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NEW WARPING, SCOURING, SIZING, DRYING, AND BEAMING MACHINE.

OUR engraving shows a form of combined sizing and warping machine, adapted alike for cotton or woolen yarn, designed and patented by Messrs. Edmund Leach & Sons, Rochdale. The arrangement of the machine is so unusual that even those of great practical experience may be pardoned for not immediately comprehending it; but, nevertheless, the many points of novelty and advantage it contains may worthily claim their attention. We have in these pages on so many occasions treated at length the subjects of warping and sizing, and have at the same time described so many excellent machines adapted for each process, that detailed descriptions of the ordinary methods are now not called for. In order, however, to make the merits of this particular machine apparent it is necessary that we shall go over part of the ground we have already trodden. To pass the yarn from the warper's bobbin to the weaver's beam is an operation which can only be performed in several stages, and one of them is the process of sizing, which, as we have repeatedly pointed out, is highly advantageous, if, indeed, not indispensable for facilitating the work of the weaver. Warping, sizing, and beaming involve a number of manipulations of the yarn, which it would obviously be beneficial to reduce. Beam warping machines, on the grounds of facility in working and amount of production, have much in their favor, as compared with the old warping mill, and the superiority is further enhanced by the fact that yarn warped in a beam warping machine places itself with greater regularity on the weaver's beam than does that warped on a mill reel, and consequently produces better cloth with greater ease to the weaver and more profit to the manufacturer. Beam warping, however, as ordinarily conducted on plain beams, has some important drawbacks. It requires several beams to make a complete warp, and unless the warps on each beam are all accurately marked to the same length, when combined together into one warp in passing through the sizing machine, all yarn left on the three or four beams after the shortest warp is wound off is so much waste. There is, further, the danger of the completed warp being too short for the requisite number of pieces, and here again loss, as represented in odd lengths of cloth, is entailed. With woolen goods this is a matter of very serious import, with cotton scarcely so much; but it is still the defect to which beam warping in the usual machines is liable.

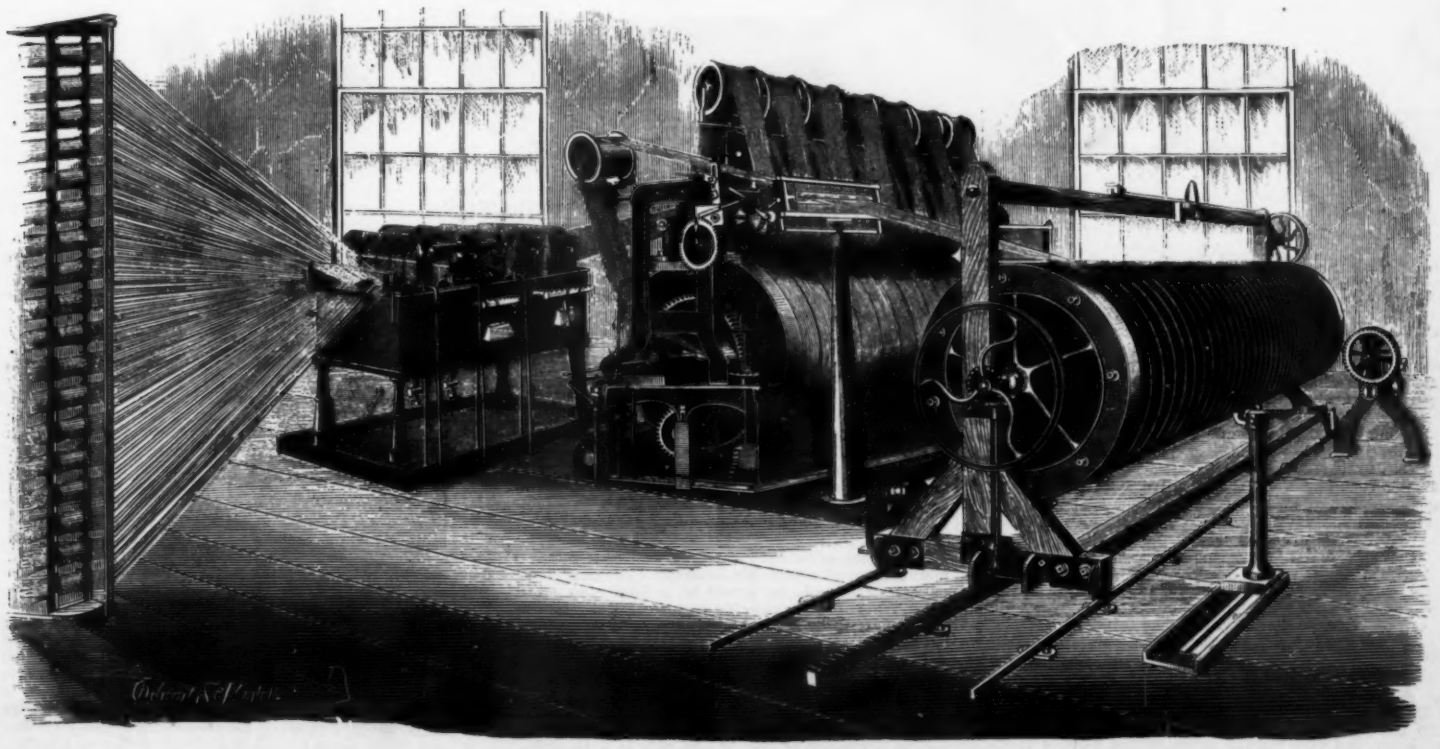
To overcome this disadvantage the method of warping on section beams (that is to say, beams divided along their length by means of thin flanges into sections) have been introduced, and with this plan Messrs. Leach have for many years identified themselves. In warping on the section beam, or, as with greater propriety it must be called, the section barrel, the sections are filled successively, each with yarn of the required number of ends to the inch for the particular kind of work to be woven. The machines in every case are provided with mechanism which indicates the length of warp wound in, say, the first section; when the required length has been attained, the attendant stops the machine, cuts the ends, ties them in a bunch-knot, and hooks it on a pin in the next section. Before starting to fill this one he makes an adjustment with the indicator, which causes a bell to ring when the second section has wound exactly the same length of warp as the first, when the machine is once more stopped; and similarly with the third, fourth, and remaining sections. If the cloth to be woven is narrow, a few sections will make up its width, a larger number being filled when the piece is to be wide. When the number of sections required to give the proper width have been filled, a beam is placed alongside the section barrel, and the warp, now complete, wound on to it, the beam being afterward conveyed to the sizing machine, or the loom, as may be necessary. Such, in general terms, is the process of warping with the section beam. In the machine illustrated in our supplement, to this operation is added that of sizing, the yarn passing through the size as it is conveyed from the bobbins to the barrel. A reference to the engraving will show that the creel is placed on the left hand, the yarn being led from the bobbins placed thereon to the size-box, and thence, after passing several times underneath the drying cylinder, to the section of the barrel in which, for the time, it is being wound. In a machine we examined, employed for sizing woolen yarn, the creel was constructed to hold 500 bobbins, although, of course, only the number necessary to fill the sections with the required number of ends to the inch are used. The ends are passed, two or four at a time, through the porcelain eyelets of a dividing plate situated on the front end of the sizing-box. Sometimes, however, as shown in the illustration, they merely pass through the dents of a reed, with the suitable number of ends in a dent. The tank, shown supported on dwarf columns, is divided transversely into three portions; the one nearest the reed, or dividing plate, contains an ammoniacal solution, the middle one contains water, the other, toward the background, being the size-box proper. All are kept hot by means of steam; the size-box by a steam chamber at its bottom, so that the size undergoes no dilution from the admixture of water from the condensed steam. The yarn is conveyed first through the ammoniacal bath, through which it is twice transmitted, passing over rollers placed above and under rollers immersed in the solution; and by this treatment grease, dirt, and other foreign matter which would interfere with the disposition or the proper adhesion of the size are effectually removed. Before the layer of yarn reaches the size-box it is squeezed with a pair of rollers, one of which is weighted by means of a lever with adjustable counterweight, and the excess of solution carried along with it is thus pressed out and returned to its receptacle. The weighting levers are shown on the front side of the tank. The yarn, now in the proper condition, clean and wet, to receive the size, is sent through the latter by the aid of a similar disposition of rollers as with the scouring process. The excess of size left in the warp as it leaves the box is likewise removed by a pair of pressure rollers weighted as before with a lever and counterweight.

We come now to the drying arrangement, which is placed between the size-box and the sectional barrel. An ample drying area is provided by the surface of the three cylinders, the largest, placed lowermost, being 48 inches diameter, the other two placed above, and side by side, 12 inches diameter, all three being about 10 feet long. Only one of the small drying cylinders can be seen in the perspective view. The short rollers, placed above and disposed obliquely with respect to the cylinders, are merely guide-rollers, and with their assistance the two faces of the warp are alternately presented to the drying surfaces. The warp (or, more strictly, the narrow sections of a complete warp) enters on the drying cylinders at the further extremity of the machine; it is conveyed in a spiral fashion partially around the cylinders, so that it is brought thirteen times into contact with the drying surfaces; or, to put it in another way, in passing through the machine, it is acted upon for a longer time than in existing arrangements. From this it follows that the passage may be rapid while the drying is still perfect. The last coils of the warp finally leave the near end of the large cylinder, and, after passing over a guide-roller, clearly shown, goes through the first reed, which, when a lease is required, is made a leasing-reed. The second reed and the one contiguous to the sectional barrel is made of the proper count for the desired kind of cloth, in this reed it being usual to put four ends in a dent. Both reeds admit of a slight longitudinal adjustment, but the columns on which they rest are stationary, being securely fixed to the floor. The beam warping portion, seen on the left hand, is very simple in construction. The combined machine we inspected was very large, the section barrel being about three feet in diameter and about 13 feet long, divided by fixed sheet-iron flanges into 36 sections, each 4¼ inches wide. In the woolen trade, in the surrounding districts, it is found that, for the counts in use, this width is most convenient.

The barrel, it will be observed, is mounted on a carriage, movable on rails fixed in the floor. The object of this is to allow every section to be brought opposite to the reed, for the purpose of winding the warp in a direct line from the last guide roller. This plan is preferable to having a reed movable from one end of the barrel to the other, for then the yarn would be deflected sideways at considerable angles, and danger of undue friction on it would thereby be induced.

The indicator consists of a fine-threaded screw placed along the top rail of the carriage, and provided with a movable half nut; it carries a pointer, which, passing along a scale marked on the rail, is the index. The screw is worked by the revolutions of the barrel. The half-nut advancing along the scale indicates the yarn as it is being wound on, and when in each section the proper amount is coiled it rings the bell. On the frame of the drying machine an adjustable automatic marking apparatus is placed, by which the warp as it passes is marked into the desired lengths for the pieces to be woven. The brackets to the extreme right are provided for holding the loom beam, as it is being revolved, to wind off the separate portions of warp from the sections into a complete one on the beam.

Several of the advantages of the arrangement will now, we trust, be sufficiently obvious to our readers. Our own inspection showed us that the quality and quantity of the work done left nothing to be desired. On the back beam of the loom the warp lays itself with almost perfect parallelism and regularity, so that no lease rods are required. Every end is of the same length—an important point—which avoids the shorter being unduly strained by the treading, and which gives as a result an even cloth, which comes up well in the milling. The weaver's work is facilitated by the absence of twisted threads and twisted half-beers, and the manufacturer obtains an increased production from the same looms. To give an idea of the capacity of the machine



NEW WARPING, SCOURING, SIZING, DRYING AND BEAMING MACHINE.

it will be sufficient for us to state that one machine warping for unions and flannels is capable of keeping seventy 126-inch looms constantly at work.—*Textile Manufacturer.*

ON STEEL CASTING APPARATUS.*

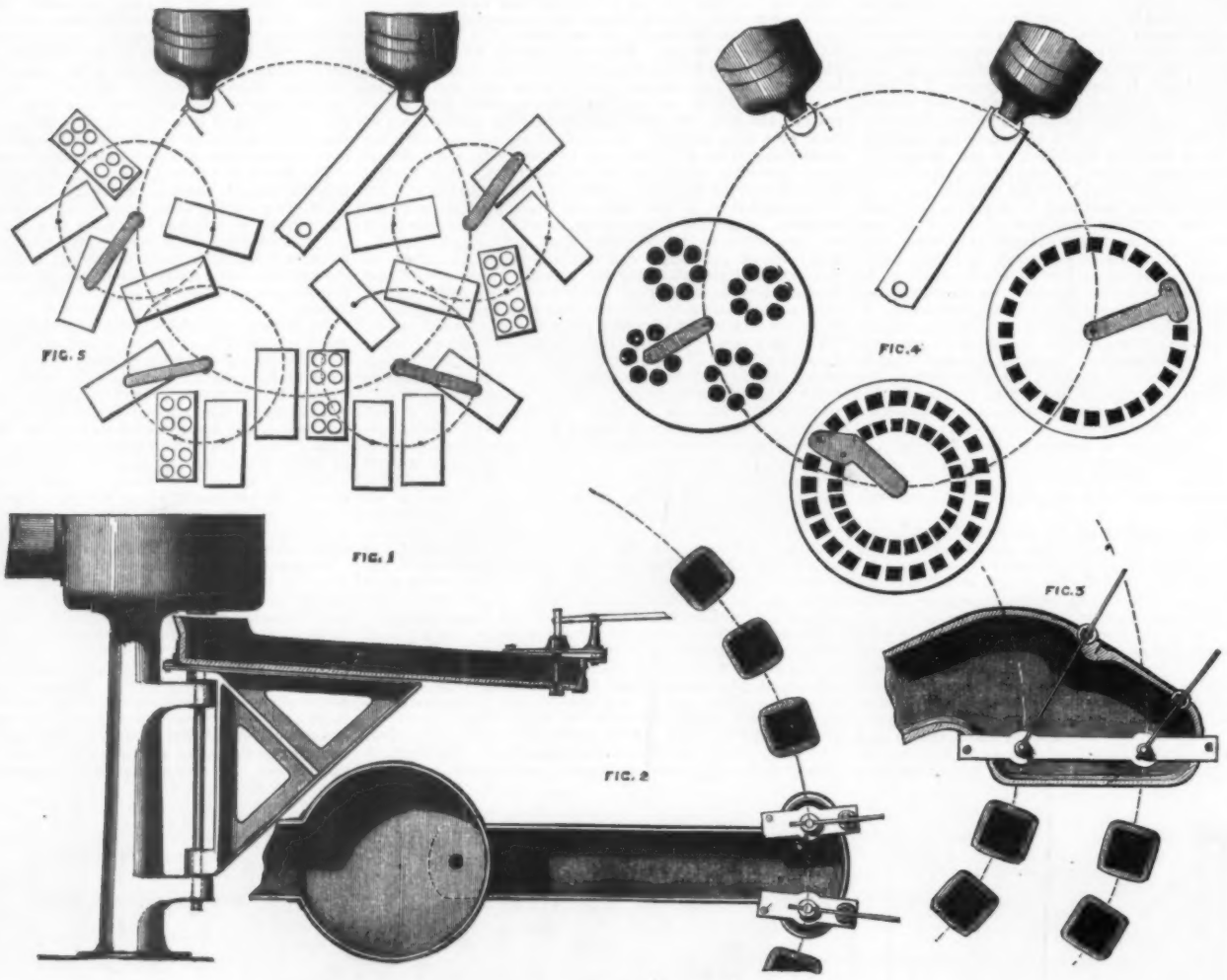
By MR. MICHAEL SCOTT, Mem. Inst. C.E., F.R.S.E.

THE object of this paper is briefly to describe an apparatus which has been successfully applied to the Siemens open hearth steel melting furnace, in order to facilitate the casting of ingots, and to suggest its use, in a modified form, in Bessemer pits. Figs. 1 and 2 represent, with some minor differences, the apparatus as applied, with Dr. Siemens' approval, to two 10-ton furnaces at the Railway Steel Works, near Manchester, in June last, where it has given much satisfaction. It will be observed that it consists of a spout or trough made of boiler plate, closed at both ends, and mounted upon a little crane hinged to an iron column, upon which rests the ladle which primarily receives the metal from the furnace. The spout and crane are free to revolve on the vertical axis of the latter in a horizontal plane, and the moulds being arranged circularly around the column, the outer end of the spout is brought successively over one or more moulds, when, the small stoppers being raised by the levers shown, metal flowing from the ladle passes into the moulds. The small stoppers are then lowered, so as to close the orifices in the nozzles and stop the flow of metal through them, and the spout is turned until it is over another pair of moulds, which are filled in a similar manner, and so on until all the metal is run. The moulds may be arranged in one or more concentric circles, and a form of spout which has been adopted for filling two such circles is shown at Fig. 3. When groups of moulds are to be filled, a single-ended spout with ladle head or spout. The stoppers are not troublesome. As I have said, the large one in the ladle head once opened does not require to be closed during the running; and the spout-stoppers, working as they do in a depth of only a few inches of metal, are not liable to get out of order or to stick, so that practically it may be affirmed there is no leakage or spilling of metal, which is so common when running from ordinary ladles.

If a cold set should take place with the apparatus described, it would indicate great carelessness, because the metal is run so quickly, and the flow does not depend upon the working of the large stopper when it has once been opened. Moreover, provision is made for removing the metal from the ladle head should the stopper stick fast before the commencement of the run. The spouts are lined with tiles, and the lining is durable; as the spouts are secured to the crane by a single bolt, they can readily be removed and replaced, and they can be heated in a stove. At first sight one might be apprehensive that the metal passing along the spout would be unduly cooled, but experience has shown that this need not be feared. As I have explained, the spouts are lined with a non-conducting material; they are heated, and should not be put on the crane until the furnace is ready to be tapped. Then the metal flows very rapidly and in volume, so that the cooling influence of the spout is very little felt. When the manganese is added to the charge in the furnace, the rapidity with which the metal is run out is an advantage, as the loss of manganese is less. When the manganese is added to the metal after it has left the furnace, the apparatus is not unsuitable, although, while adhering to the same principle, I would suggest other arrangements, but these do not fall within the scope of the present paper. It will be observed that, compared with running from a large ladle so far as the moulds are concerned, the head of metal is diminished and is always the same, thus producing uniformity in the flow, and reducing the splashing. Moreover, the men teeming see what they are doing much better than when the mould, being filled, is underneath a large ladle, and the stoppers are so easily worked that the exact quantity of metal which is required can be poured. The spout is moved with one hand with great facility, and even supposing the stopper was leaky, the pressure of metal is so little that the loss would be greatly reduced; but, in point of fact, the absence of spilling is one of the most satisfactory elements in the working of the apparatus. The extremely inexpensive character of the arrangement commends it to notice. The cost of the apparatus shown is only about £50, which is far less than the ordinary system of ladles, carriages, and pits, and the cost of maintenance is in a similar proportion. The revolving spout also produces a decided economy in working.

Application of the Revolving Spout to Bessemer Pits.—I suppose that we all admire Mr. Bessemer's pit arrangements and apparatus; indeed, he would be a bold man who would venture to alter their essential features. But minor improvements have been made, notably by our American brethren, led by Mr. Holley; and among other things it has been shown how a very large output of metal can be obtained from a single pit with a pair of moderate-sized converters. This has been done when large moulds producing heavy ingots have been employed; but I am not aware that within a given time a great number of light ingots have been turned out; and yet, as in the case of tire blanks, this is a result which it would be desirable to effect. The fact that in America light steel tires are not so much used as with us, and the consideration that the system of casting heavy ingots has its advantages, may have prevented steel-makers in that country from arranging their pits for the production of light work; and it is well known that some of our friends in England are also in favor of big ingots; but as good rails and tires can be produced from smaller ingots, some have preferred to economize the power required to reduce large masses, and to cast them more nearly of the size of the finished product. Proceeding in this direction, I now propose to indicate how the revolving spout previously described could be applied to facilitate casting in a Bessemer pit. To turn out a greater number of ingots, it is obvious that to avoid complicated and expensive machinery more room would be required, and the tendency which appears to exist generally among steel-makers to enlarge their pits shows that they consider that more space is desirable. Engineers will acknowledge, as a rule, that crowding work into a limited space is disadvantageous, and as it may—not to say must—involve rehandling, it cannot be economical. If this be true as regards ordinary work, it is surely much more important when we have to deal with hot moulds and ingots, mere proximity to which is distressing to the workmen. All will concur in the view that the safety and comfort of the men should be carefully considered; and many can testify from experience that it is wise to consult their welfare, even on the low ground of economic results.

In passing, I may refer to the fact that if moulds are worked very hot the ingot is not so readily detached from them as when cooler; and hence the moulds, and consequently the ingots, require to be more tapered, which is not advantageous either for hammering or rolling; but by having plenty of room in the pit more moulds may be in work, and as they would not require to be filled so frequently, they would not become so hot. From the great weight to be carried it would not be convenient to increase the radius of the central ladle crane, as ordinarily constructed. Indeed, while with the usual radius of, say, 16 ft., 5 or 6-ton charges are manageable, with the charge increased to 10 tons, if the radius of the crane were augmented so as to cover a proportionate additional space, the crane would become costly and unwieldy; and in filling numerous moulds it would be difficult to start and to stop in the exact position required. Therefore, for the purpose of comparison, I have assumed a radius of 16 ft. from the center of the crane to the center of the ladle. But I hope to show that, by the use of the revolving spout, this radius might be diminished, and it appears to me that a more simple and less costly machine might be substituted for the ordinary central crane. I have not had time, and, therefore, do not propose on the present occasion, to go into this latter point; and as the crane usually employed is within limits a very efficient instrument, I suppose it to be used in combination with the revolving spout. Considering the large output from a Bessemer pit in order to provide for a variety of sizes of ingots, it might be well to make the height of the spouts variable at pleasure. This could easily be effected by more than one method which will no doubt occur to engineers, so I need not occupy the time of the meeting by discussing them. I have prepared two sketches which show typically how pits might be arranged with the revolving spout. In Fig. 4 there is shown, first, a circle of twenty-six moulds run from the top by a double-ended spout, 7 ft. 6 ins. between centers, filling two moulds at a time; second, two concentric circles, making together fifty moulds, run from the top by a double-ended spout, 7 ft. 6 ins. and 6 ft. between centers, filling two moulds at a time;



SCOTT'S STEEL CASTING APPARATUS.

one stopper is employed, and the several gits are arranged circularly round its vertical axis. The spout—not mounted in the manner shown—can be made of such dimensions that it can receive, as a ladle, the whole charge of the furnace, and the form may be varied to suit different requirements; but it has not been thought necessary to describe other arrangements in the present communication. The apparatus was started without a hitch, and has been found to work very satisfactorily. In running open-topped moulds, a pit of 15 ft. diameter was found sufficient for the produce of a 10-ton Siemens-Martin scrap furnace, and in a pit of 18 ft. diameter there is room for thirty-eight moulds at a time, if arranged in two concentric circles, the ingots weighing about 12 cwts. each, or about 23 tons in all. As only about half such a number of moulds is required for a charge, there is ample time to remove the ingots and replace the moulds, and by filling those on one side of the pit, the men working at the other side need not be exposed to excessive heat. The nozzle in the ladle head is 3 ins. in diameter, and the nozzles at the end of the spout vary from 1¼ in. upward. When the smaller nozzles are used, the large ladle-stopper should be lowered so as to diminish the flow till near the end; but it does not require to be closed, because the spout contains the metal which flows into it during the brief interval required to move it from one to another pair of moulds, when the small stoppers are shut. From the large size of the nozzles the metal is run very quickly; ten tons can be poured into the moulds in seven or eight minutes, or even less, if necessary, and very little or no skulls are formed either in

* Iron and Steel Institute.

third, four groups of seven moulds, each group filled from below through a central runner by a single-ended spout, 5 ft. 6 ins. between centers. These groups may be supposed to consist of tire blank moulds, in tiers three high, in which event there would be in each group twenty-one moulds, in the four groups eighty-four moulds; and, if the whole pit were employed for casting blanks in this manner, there would be space for 252 moulds on the floor at a time. If, on the other hand, rail ingots were being cast, then, if arranged in single circles, there would be room for seventy-eight moulds at a time, which would cast a great weight of ingots—of course, if double circles of moulds were employed the number would be augmented to 150. The second sketch, Fig. 5, shows a different arrangement, and single tire blank moulds introduced. With the aid of four single-ended revolving spouts, each 7 ft. 6 ins. between centers, twenty sets of moulds may be filled, and as each set is composed of eight, there is thus room for 160 moulds at a time. The red circles show the radius of the ordinary central casting crane, supposed to be 16 ft. This would give a circumference of 100 ft. nearly; off this let there be deducted, say, one-third on the side where the converters are placed, as unavailable for casting; this leaves 77 ft., and if moulds were placed 22 ins. from center to center, there would be space for forty-two moulds. This would not be much more than half the number with the spouts if in single circles, or a little over a fourth if in double circles. Then casting in groups: Assuming groups of seven moulds to measure about 7 ft. from center to center, with an ordinary central crane and a pit 40 ft. in diameter, there would be space for eleven groups, or seventy-seven moulds, but the increased size of the pit would not be convenient when running open-topped moulds, while with three revolving spouts, operating in circles 17½ ft. diameter, there would be space for twelve groups, or eighty-four moulds. For casting blanks in single moulds: If the sole plates were arranged radially and placed close together, an ordinary ladle crane might command twelve sets of eight moulds each, equal to ninety-six moulds in all, whereas the sketch shows that with four spouts there would be room for 160 moulds. The system possesses considerable flexibility, for the columns bearing the spouts could be shifted as required, and spouts of different lengths being available, the arrangement of moulds might be varied at pleasure. For casting light ingots there would be ample space, and for heavy ingots there would be more working room and better ventilation than in ordinary pits. When running from the top, if the revolving spout were employed, for every two moulds filled there would be a weight of about 13 cwts. moved over 1 ft., and the flow of metal from the ladle would never cease, while in the case of the ordinary arrangement there would be a mean weight of about 8 tons to be moved twice over the same space, and the flow of metal would be shut off at every mould. The cost of a revolving spout and the supporting column would only be about £50. I have not shown ingot lifting cranes, as they may be of the usual kind or otherwise.—*Engineer.*

A PECULIAR CASE OF FAILURE IN A WATER MAIN.

A Paper by D. McN. STAUFFER, C.E., Member of the American Society of Civil Engineers.

THE accompanying sketch illustrates what, to the best of my knowledge, is a unique case of failure in a water main, and is sufficiently curious to be noted.

As shown on the drawing, a hole 1 in. x ⅛ in. was scoured entirely through a cast-iron pipe ¾ in. thick and 4 inches inside diameter. Unfortunately the break was repaired and the lead melted out of the "bell" of the adjoining pipe before an observation could be made, so that we can only get at the cause by an examination of the injured portion of the pipe.

The water flowing through this pipe is supplied from a reservoir 5½ miles distant, and at an elevation of 280 feet above the portion in question. The pressure taken at the nearest fire-plug varies from 80 to 100 lbs. per square inch, depending upon the time of observation and the amount of water being drawn off. The soil in which the pipe is laid contains much fine, sharp sand, and it is the presence of this sharp sand, we take it, that accounts for the mischief.

The hole was in the *top* of the pipe, and is evidently the result of a scouring action; there is no sign whatever of a flaw in the iron, which is of an excellent quality.

The cause was apparently as follows: The lead used in making the joint was, very probably, carelessly poured and as imperfectly calked, leaving a weak spot in the joint at the "pouring gate," on top of the pipe.

The lead giving way under the pressure, allowed a small jet of water under an average pressure of 90 lbs. per square inch to strike the pipe just outside of the bell. The soil above, mainly sharp sand, continually caving in from the action of the water, furnished an excellent grinding material, and the jet was the active agent, thus forming, in fact, a natural "sand-blast," exactly similar in effect to the machine so usefully applied by Mr. Tilghman. The outside of the pipe was brightly scoured within the limits indicated by the dotted lines on the drawing, and grains of sharp sand were still imbedded in the pits shown in the sketch. Just how the grinding material got *under* the "bell," as it evidently did, is the one thing not easily explained, as there is no evidence of any sand *within* the pipe. Four days before the water burst through the injured pipe, this joint was laid bare in making some repairs, and there was no leak then apparent, so that this ⅜ in. of cast iron must have been scoured through *within* that time.

DISCUSSION.

Mr. George S. Greene, Jr.—I think this not a very uncommon case of failure. Mr. A. W. Craven, when Chief Engineer of the Croton Aqueduct, had in his office specimens of pipe cut by sand and a current of water. The explanation given in the paper by Mr. Stauffer appears fairly to account for the effect produced, although the time, four days, seems somewhat short for cutting through a pipe ⅜ in. thick.

Mr. W. H. Paine.—At the caisson for the foundation of the Brooklyn Bridge, sand was blown out through a pipe 3½ ins. diameter (a short piece at the lower end was only 2½ ins. diameter). At the upper end an elbow was necessary to properly direct the stream of sand. The iron in these elbows was ⅜ in. thick. Under a pressure of 34½ pounds, the greatest pressure, the stream of sand cut through every kind of iron tried except Franklinite, in one half hour. Franklinite stood longer.

Mr. C. L. McAlpine.—A similar tube was used at the Harlem River Bridge for months, at about the same pressure as that mentioned by Mr. Paine, but with no perceptible wear of the pipe, although a large quantity of sharp sand, gravel and stones was ejected with a force that sent stones through the atmospheric air to a distance of 60 feet.

Mr. Wm. J. McAlpine.—I have closely examined the pipe in question, and with a new, sharp file. I find the edges of the hole to be a white, chilled iron, and other parts of the pipe of materials of various grades, from very soft to very hard iron. In some places I have picked out some of the material with the point of a pocket knife. The pipe was undoubtedly a defective one, and at the place in it where the leak occurred, scoria or other imperfect material with no more consistency than coke overlaid the very thin sheet of hard iron. The latter was evidently *too weak* to withstand the internal pressure of the water.

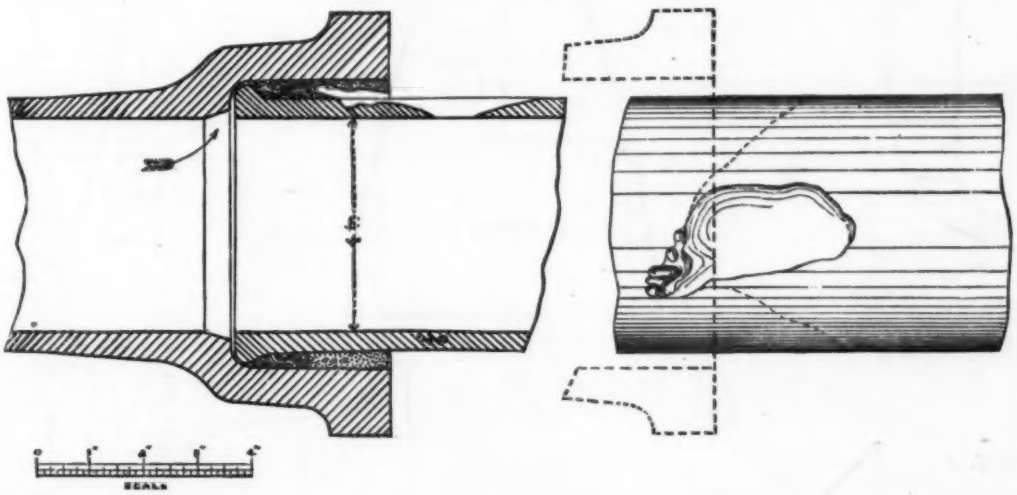
The theory of the author of the paper is that the water that produced the scour escaped from an adjoining bell-joint. The action of the leakage water, under the circumstances, would make two short, nearly right angle turns, and after finally escaping, would be projected in a nearly horizontal direction parallel to the pipe, and thus encountering a rounded surface of iron on one side and the natural earths on the other, as mentioned by the author, its force would be so diffused that it could only act upon the weaker material—the sand—and would have no force left to act upon the iron.

If the iron pipe contained scoria also, as the surface showed, it would have but little coherence or strength, and its surface might be rapidly worn away, and produce the result which the specimen exhibits. This specimen evidently had not sufficient strength to resist the pressure of water from the interior of the pipe to which it is said to have been subjected.

I differ entirely from the author's theory that the hole in this pipe was or could have been produced by or on the principle of a "sand-blast," so called.

IMPROVEMENTS IN BICYCLES.

THE great objection to the bicycle—especially on the part of those who would like to use it as a means of rambling about the country—is the necessity for dismounting when the rider wishes to stay for a few minutes for the better observance of any object of interest, and dismounting and mounting are themselves attended with some risk to all except the most agile. There are, however, objections of equal or greater weight to the tricycle and the four-wheeler, and for some years the attention of certain makers of these machines has been devoted to the construction of a velocipede combining the advantages of the bicycle with those of the tricycle or the common velocipede. Figs. 1 and 2 represent a method by which Mr. J. Turner, of Coventry, Eng., proposes to combine the well-known advantages of the bicycle with the facilities offered by three and four-wheeled velocipedes to the timid rider in mounting and dismounting. He applies to the bicycle a pair of small wheels so arranged that they will serve to support the vehicle in an upright position when brought to the ground, and will admit of being raised clear of the ground when the vehicle is running, so that no impediment will be offered either to the running of the bicycle or to the action of the rider. These wheels will run on either side and abreast of the front wheel. When these supplementary wheels are on the ground the rider, however inexperienced, can mount the vehicle without risk of a fall, and can start it with facility; and when fairly under way he can then raise the two small wheels clear of the ground, fix them in their raised position, and proceed on the two center wheels as on an ordinary bicycle. When wishing to stop, the rider has merely to lower or depress the two small wheels, lock them in their depressed position, and he can then dismount at pleasure. The prongs of the fork are formed with a tubular pendent extension, F F, to receive the wheel stalks, G G, of the lateral supporting wheels, H, and form supports and guides for the stalks to slide in. Jointed to the upper end of these wheel stalks are rods, pendent from a cross bar, the ends of which are joined to arms, K, keyed to the stem of the steering handle. This handle is mounted in a swivel bearing connected to the upper end of the fork, and it is so fitted as to allow of its receiving an axial motion in its bearing. The axial motion of the steering handle is for the purpose of lifting the arms, K, and throwing them up in order to lift the wheels, H, from the ground; and the mounting of the handle in a swivel bearing allows for either of these wheels, H, rising on meeting an obstruction on the road without interfering with the motion of the velocipede. The rods are cranked, to allow of the arms when thrown up taking the position shown at Fig. 2, when, by reason of the joints which couple the arms and rods respectively together being thrown past the center of the steering handle, the wheels, H, will have no tendency to drop. When these wheels are upon the ground the joints, being in the position shown at Fig. 1, will resist all tendency to yield to the upward pressure of the wheels, H; but on turning the steering handle on its axis, and thereby bending the joints outward, the wheels will be unlocked and free to rise from the ground. To facilitate this movement coiled springs are fitted to the wheel stalks, G, above their guides, F, which springs, coming into action as the joints are bent outward, will lift the wheels clear of the ground. They are then to be locked out of action by completing the half-turn of the steering handle. The provision for giving the steering handle an axial motion and a tipping motion, as above explained, will in no way detract from its efficiency as a steering handle, for, its bearing being attached to the fork head in a manner that permits of no independent horizontal motion of the parts, it will act upon the fork in precisely the same manner as if it were bolted thereto.



Figs. 3, 4, and 5 show sections of improved fellies patented by Messrs. Beck & Warwick, of Birmingham, the object being to gain extra strength at the part where the felly is pierced for the spoke, and to protect the tire from injury by the spoke, while retaining the circular groove for the tire. In Fig. 3 the felly is rolled with a flange, which is clipped by a fork on the spoke; but in Figs. 4 and 5 the metal is thickest where the hole for the spoke is required, and in the case of Fig. 4 it will be seen there is space for a large head to the spoke without running any risk of injuring the tire. The patentees also claim the invention of an improved tire, which consists in covering a core formed of any fibrous material, such as rope, made either of cotton or hemp, or both (or a tube of metal of any suitable kind may be employed, and, if necessary, may first be covered with hemp or other suitable padding material), with India-rubber, either tubular or coiled in strips.—*English Mechanic.*

NEW DESIGNS FOR WAR AND MERCHANT VESSELS.

THE first and most prominent idea in these designs, which are by Edmund Thompson of London, is the admirable one of making all vessels absolutely unsinkable, by means of air tubes and cells. This is supposed to be done to some extent already, but Mr. Thompson carries this practice to its utmost extreme. He maintains that however a ship may be damaged, what is left of it ought to float, in order to give its crew a chance of life. The second point is in the position of the screw propeller, which involves an alteration in design of the rear half of the vessel. Forward the vessel is of the usual form, the after end being formed into two bodies, between which the screw is placed. This is to avoid vibration, racing, slip and injury from missiles or collisions. The third point relates especially to war ships, and involves carrying the armor-plating inside the air tubes instead of on the extreme outside as at present, thus reducing the tendency to roll and liability to capsize. Steel is proposed to be used in preference to iron throughout.

In Fig. 1 is shown the half midship section of a cellular framed ocean steam or sailing ship, and in Fig. 6 the same design, modified for a war vessel, wherein a 3-foot armor-plate rests upon a box-girder shelfing carried up from the floor of the ship inside, but attached to the frame of the ship. Fig. 2 gives a plan of the forward end of the vessel, showing the proposed construction of collision and other bulkheads. Fig. 3 is an after section, showing the position of the screw within a tunnel, which divides the two bodies in the rear. Fig. 4 illustrates the same point, being a half section of the after end of a vessel at the point where the single body divides into two. This figure is also utilized to show the method of protecting a vessel from attack by torpedoes by means of a metallic chain attached to falling davits, which are supported by chains by passing through pulleys in an upright pillar frame round drums, which are worked by steam-power, whereby the chains can be raised or lowered at pleasure. This plan of falling davits should also be employed for lowering boats, or raising them out of the water, for which its advantages are unquestionable. Fig. 5 is a midship section of a cellular frame for a war ship, showing the position of the shelf for armor-plating inside the frame of the vessel.

In the limited space at our disposal it will be impossible to give an adequate description of the remarkably suggestive designs of Mr. Thompson. That they are capable of improvement he will, no doubt, fully admit—in fact, since our illustrations have been prepared, a few modifications have been effected. The outside dimensions of one of his types are to be 350 feet by 50 feet by 30 feet; those for tonnage (N. M.) 300 by 40 by 30; the register tonnage about 4,000 tons; displacement, 9,000; and estimated weight of hull 1,500 tons—a remarkably light vessel, with full poop, forecastle and deck houses.

"The frame and floor plates will be formed of ¼-inch steel plates, flanged for riveting at each side; flat on the inner side, so as to constitute the hold into an oblong box, no cargo being allowed at the ends. The measurement space for cargo is thus identical with the number of cubic feet for tonnage. The frames will be 5 feet in width at the gunwale, and diminish to about 2 feet at the bilge, where they will rest on floor-plates. The frame and floor plates are spaced 6 feet apart, the former being connected together by tie-plates, and the latter by intercostal kelsons spaced also 6 feet apart. The whole frame is then plated over with ¼-inch steel inside and out, and forms a cellular or honeycomb shell. The beams and kelsons are all of the box form. The main deck beams rest on the top of the frames, and are arched with one foot of spring to give additional strength. The lower beams are supported on longitudinal shelf-pieces attached to the inner skin. The spar deck is formed of frames connected together in the same manner, but it is not proposed to plate them inside. All the hatches are trunked up, and the transverse bulkheads are carried up to the upper deck, so that in case of accident, from water or fire, the damage would be localized. The whole of the decks are steel, and may be covered with cement or sheathed with wood. It is recommended, for a mercantile vessel, that she should be sheathed with 3 inches of wooden planking. Thus, with the rigidity of her frame, copper would wear fully five years, and graving dock expenses thereby be saved. Water ballast can be carried in the bilge kelsons and in the compartments between the floors. In a steamship the water so carried should be fresh. The boilers may thus be supplied with fresh water the entire voyage, the condensed water being returned to the bottom tanks. The bilge kelsons, while being no impediment to sailing, will be of the utmost value in balancing, when required, the upper weights by means of the water contained in them. They would further serve for docking purposes, and in foreign ports, where it is difficult and expensive to form graving docks, a system of pontoons would be equally effective for the purpose of cleaning or repairing the bottom of the ship. They would, moreover, be a great protection to the hull of the vessel if she should unfortunately get ashore; and certainly, combined with the cellular formation of the hull, prevent the possibility of the ship breaking her back when so situated.

"In a war ship the armor-plating will be carried on a girder shelfing inside of but attached to the frame of the ship. Thus three feet of armor may be carried; and if the air-tubes or width of the frame of the ship is extended, there is no reason why armor 6 feet in thickness may not also be carried. The war ship would be planked over with 6 inches of teak and coppered. When the vessel goes into action, water would be introduced between the frames, so as to bring her nearly level with the main deck. A shot, therefore, striking below this deck, would lose much of its force after passing through the teak and steel plate and the water between the frames.

"The screw-propeller will be placed about 60 feet inside the stern-posts, the after section being divided or tunneled into two bodies, 20 feet in width and depth, so as to admit a full-sized three or four bladed propeller. The propeller, if desired, could easily be raised, but this is not recommended. The two bodies would be connected by strong box girder beams arched underneath. The rudder will be placed between the after stern-posts, whereby excellent steering properties will be obtained. The advantages of this position for the propeller are—absence of racing, comparative freedom from vibration and slip of the screw. When the propeller is disconnected it will be no impediment to sailing. The saving of fuel, by the use of canvas when the wind is favorable, would, on a long voyage, be very great—probably, under favorable circumstances, about one-half."—*Iron.*

Fig. 1.

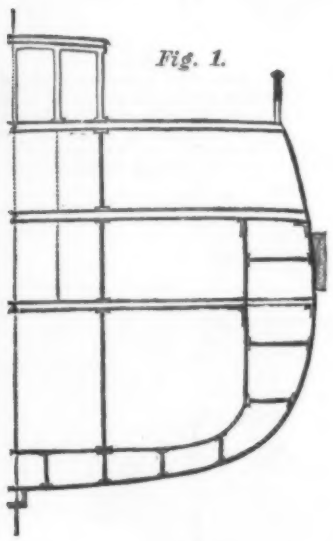


Fig. 2.

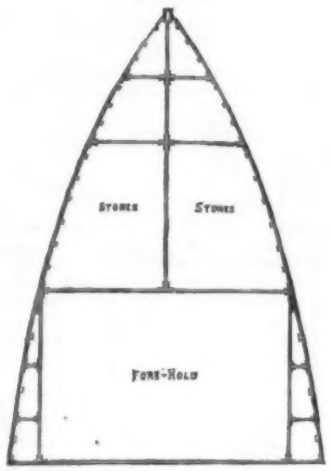


Fig. 3.

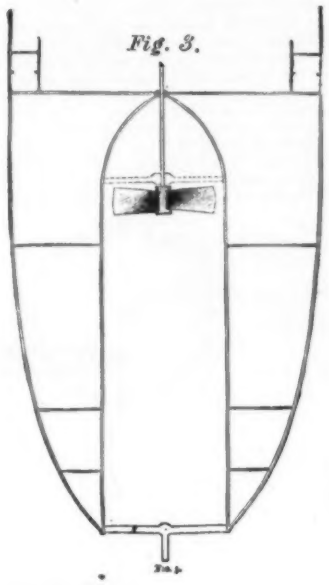


Fig. 4.

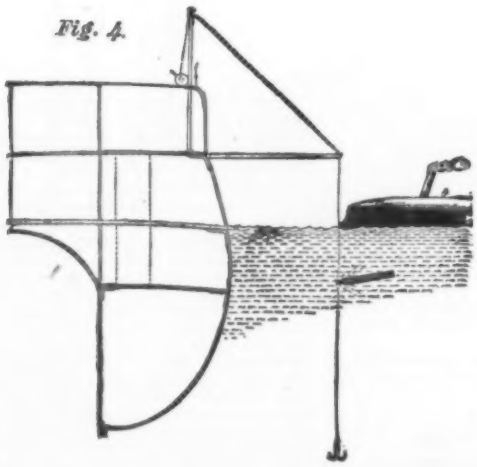


Fig. 6.

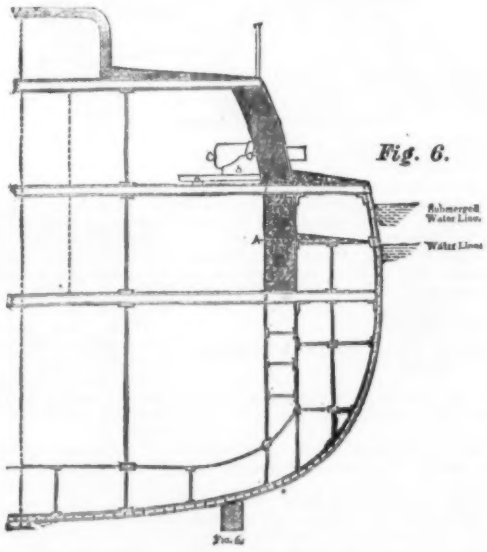
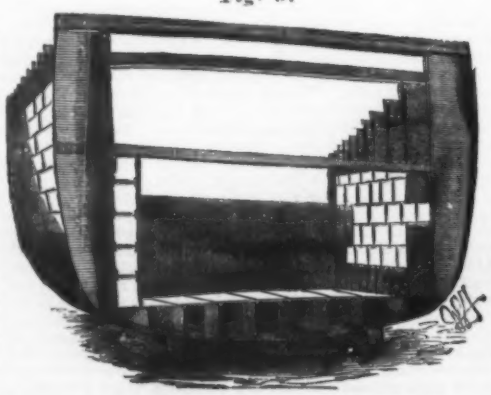


Fig. 5.



A SOLID ACRE OF SILVER.—The *Rocky Mountain Tourist* says: "One of the most remarkable mines in California Gulch is in leads 3 ft. in thickness, the ore from which yields from 240 ozs. to 270 ozs. of silver to the ton, and lies like a coal bank in a stratification of limestone, dipping about 15°. Two openings have been made at points 600 ft. apart, and sufficient ore is in sight to make millions of the 'dollars of our daddies.' The owners have gone far enough to know that there is a full acre of the ore in the one solid body, and some conception may be formed of the amazing richness of this discovery by a brief calculation of its dimensions. A cubic foot weighs 170 lbs., and as the ore lies 12 cubic feet make a ton. There are 43,560 square feet in an acre, and the acre of ore being 3 ft. in thickness makes 130,680 cubic feet, which with 12 cubic feet to the ton makes 10,900 tons, worth $250 per ton, or the enormous value in the aggregate of $2,700,000.

NEW DESIGNS FOR WAR AND MERCHANT VESSELS.—BY EDMUND THOMPSON.

THE PRESERVATION OF IRON SURFACES.

THE surface of iron, whether cast or wrought, invariably oxidizes and wastes when exposed to the weather, unless special precautions are taken to prevent oxidation. Were it not for this fact, iron bridges, gates, girders, or railings would be practically indestructible. As it is, the rapidity with which iron loses its good looks and its strength is so great that it is imperatively necessary that its union with oxygen should be in some way prevented. There are various schemes known to the chemist by which this end may be secured. For example, if electrical—or galvanic, to use a more popular word—conditions existed by which the iron was made to play the part of a cathode or negative pole in a voltaic circuit, it would last forever. The favorite and practical system of protection consists in covering the surface of the iron so that oxygen in either air or water cannot gain access to it. It may be covered either with a paint or with a metal which does not oxidize as readily as iron. Red lead paint affords an example of the former method of protection; "tin plate" and "galvanized iron" examples of the latter. Both expedients have defects. Paint is not in itself indestructible; it undergoes changes due to the action of air and moisture, which cause it to peel off and leave the iron bare. It is not quite air-tight, and oxygen finds its way through its pores to the metal beneath. Thus in practice paint is unsatisfactory, because it requires to be constantly renewed at considerable expense; and not unfrequently the renewal entails no small inconvenience. As a rule, repainting is not done often enough, and decay has already commenced in the iron before the painters are put to work. Thus, although paint makes iron structures more durable than they would be without it, the advantage is obtained only at considerable expense, and complete protection is very far from being secured. The drawbacks to the use of protecting coatings of metals are to be found in the facts that both zinc and tin are soft and easily abraded; that they are not readily used except on a comparatively small scale; and when iron so protected is cut or worked, uncoated edges are sure to be exposed which rust away with much rapidity. It is not remarkable that, under these circumstances, chemists have for years worked hard to give the world something which would prevent the oxidation of iron. That they have not hitherto been successful is a fact too well known to render it necessary that we should insist upon it.

Within a comparatively recent period two gentlemen, independently of each other, have directed their attention to a means of protecting iron which promises great things. The first of these is Professor Barff, of Kensington; the second, Mr. G. Bower, of St. Neots. The results produced by both are nearly identical, but the methods of manipulation employed are very different. We propose here to describe both processes. Without going into minute detail, we shall say enough to enable our readers to understand the modes of operation employed. The object in view with both inventors is to establish a coating of oxide on the surface of iron which will not undergo further change. Four different oxides of iron are known to chemists, namely, the protoxide Fe O, the sesquioxide $Fe_2 O_3$, a higher oxide sometimes known as ferric acid $Fe O_3$, and lastly, what is known as magnetic oxide $Fe_3 O_4$. The sesquioxide is common "rust," and with it and the magnetic oxide alone need we concern ourselves at present. When iron is first exposed to the action of moist air it abstracts one atom of oxygen and forms the protoxide of iron, or ferrous oxide Fe O; such an oxide has an intense affinity for more oxygen, and becomes speedily converted into sesquioxide of iron or ferric oxide, $Fe_2 O_3$; this in contact with metallic iron again becomes converted into ferrous oxide according to the equation: $Fe_2 O_3 + Fe = 3 Fe O$; this ferrous oxide being again brought into contact with a fresh supply of oxygen is again reconverted into ferric oxide or rust, and so the action goes on continually in this way, disintegrating the iron. If, however, the iron be exposed to the action of steam or air at an elevated temperature, instead of the above oxides we get a curious compound, which we have referred to above as magnetic oxide of iron, and also by many chemists called ferroso-ferric oxide, its formula making it apparently a compound of ferrous Fe O and ferric oxide $Fe_2 O_3$. The exact molecular structure of this interesting body must still be regarded as a debatable point. One thing, however, is certain, and that is that this magnetic oxide is not under ordinary conditions susceptible of change or conversion into rust by the action either of oxygen or moisture. It is obvious, then, that this magnetic oxide offers a specially good material for coating iron articles requiring protection from rust, and if this can be got on the iron as a firm, hard, coherent coating, an important problem has been solved, and the world has obtained the best possible means of protecting iron.

BARFF'S HOT STEAM PROCESS.

It must be understood that conditions essential to the formation of this oxide are the contact of oxygen with iron at a high temperature; moisture should be absent. Professor Barff, to whom appears to be due the credit of first reducing the work of protecting iron in this way to a practical condition, uses superheated steam for his purpose. At the small works at Kensington, where Professor Barff carries on his operations, two ovens stand side by side. They are lined with fire brick and fitted with iron doors. They stand about 10 ft. high, are about 10 ft. long, and together about 15 ft. wide. Beside them stands an 8-horse vertical boiler, which supplies steam at a pressure of 40 lbs. on the square inch; a much smaller boiler would suffice, but that actually used happened to be available. One of the ovens, which we shall call A, is traversed by a number of cast-iron pipes about 4 ins. in diameter and 6 ft. long. These pipes can be brought to a bright red heat by a fire lighted in a grate at the bottom of the oven. Steam is led from the boiler to a separator, where it loses all its suspended water. This separator consists of an iron box in which is placed broken pumice stone, and wire gauze screens which are requisite to prevent any impurity passing over from the boiler with the steam. From this the steam flows to the pipes in A; it traverses them and is there raised to a temperature of about 1,450 deg. Fah. It is discharged from the superheater into the oven, B, in which the articles to be oxidized have been previously brought to a dull red heat; an exposure of about six hours suffices to secure the required end. The steam is then shut off and the iron withdrawn from the oven and permitted to cool. It is then washed, and scrubbed with stiff brushes, and appears exactly as though it had been painted with that lead-colored paint so well known to engineers. It will be found on close inspection, however, that the effect is much finer than that produced by paint, and that the coating is even, close, hard, and capable when rubbed of taking something akin to a dull polish. The effect, especially in the case of small ornamental castings, is throughout excellent. The oxidized iron may be exposed to all weathers, free from paint, oil, or other protection of any kind, without the least chance that it will rust, provided actual violence is not used to chip off the coating of magnetic oxide. The Barff process consists, it will be thus seen, simply in submitting the iron to dry, clean, intensely superheated steam. The oven is pervaded by this steam, which it must not be forgotten is only at atmospheric pressure. It issues invisibly from the small chinks round the oven door, and readily ignites paper held in a current of it. The oxygen required by the iron is obtained by the decomposition of the steam. The hydrogen which remains, mingled with a certain quantity of steam, which must be allowed to escape from the oven to secure a current in it, is discharged into the superheating furnace, and we suppose burned. It would appear that steam plays no part in the process save that of a vehicle to convey oxygen at a high temperature to the heated iron. The success which has recently attended Professor Barff's exertions is, we have reason to believe from what we have seen, so complete that the process has left the field of pure investigation, and can be and is used for regular trade purposes, such as the coating of gas-piping, gutters, stack-pipes, ornamental railings, and various forms of what is conventionally known as builders' ironwork.

BOWER'S HOT AIR PROCESS.

Mr. G. Bower produces, as we have said, similar results in a different way. He dispenses altogether with the use of steam, and relies on the air for his supply of oxygen. The method adopted hitherto in the working of the air process consists in putting the iron articles to be coated into a large retort or chamber, the temperature of which is raised to a point dependent on the ultimate use to which the articles may be applied, and which ranges from a very dull to a bright red heat. Air is then passed in, the inlet and outlet pipes closed as hermetically as possible, and at the end of every hour the air is renewed and the inlet again closed. After exposure in this way for some hours, the time varying with the nature of the articles, the iron will be found to have received a perfect coating of the magnetic oxide, the color of which varies between a light and a dark gray or neutral tint of so delicate a nature as to absolutely dispense in many cases with the use of further ornamentation by painting. It may be mentioned that this process succeeds particularly well for cast iron, and, with a slight modification, which the patentee is at present working out, answers equally well for wrought iron and steel. The cost of coating iron in this way is estimated at about £1 per ton, but there is this peculiarity pertaining to the process, that whether the iron be a solid cube or mass of that weight, or whether it be distributed over thousands of articles involving an enormous increase of area, the cost remains practically the same.

Such, then, are two processes which promise to play an important part in the future. We pronounce no opinion concerning the relative value of the two systems. We have had ample opportunities of examining the work produced by both, and both are admirable; but experience is wanting to enable an opinion possessing much value to be pronounced concerning the advantages and disadvantages of the respective systems. We have therefore contented ourselves for the present with placing facts before our readers, and reserving opinions. It will be a matter for regret if processes so admirable should be applicable only to comparatively small articles. At present, however, there is no evidence that girders, boilers, roof principals, or similar structures, can be dealt with either by Professor Barff or Mr. Bower.—*Engineer.*

LOCOMOTIVES COMPARED WITH HORSES.*

A FEW weeks ago a question was asked me which I was not ready to answer at once, but which I could answer, I thought, after a few days' research. The inquiry became interesting to me as I followed it, and perhaps it may interest some of the members of the society also. The question asked me was: "How many horses would be required to perform work equivalent to that done by the locomotives in use on the railroads of Massachusetts?"

A nominal horse power is that necessary to raise 33,000 lbs. one foot high per minute, an estimate first made by Boulton & Watt in selling their steam engines. Trautwine says that this assumption can really be carried out by a strong horse day after day for 8 or 10 hours; but as an engine can work day and night without stopping, while a horse cannot, a one-horse engine can do much more work than any one such horse. Boulton & Watt meant that their one-horse engine could *at any moment* perform the work of a very strong horse.

Trautwine estimates that a good, average trained horse, weighing about half a ton, well fed and treated, can walk 10 hours per day at the rate of $2\frac{1}{2}$ miles per hour on a good level road, and exert a continuous pull or tractive force of 100 lbs. On a level piece of good road he estimates the traction at 60 lbs. per ton of load and carriage; so that the 100 lbs. of tractive force exerted by the average horse enables him to pull a load of $1\frac{2}{3}$ ton at the rate of $2\frac{1}{2}$ miles per hour for 10 hours per day on a good, level road.

Trautwine gives the weight of a train, exclusive of engine and tender, which a good locomotive, weighing 27 tons, or 60,480 lbs., all on the drivers, can haul on a level railroad, at a moderate speed, say 8 to 12 miles per hour, as 1,458 tons, an estimate corresponding very nearly with the amount of work which the Baldwin Company guarantee their locomotives of similar size to perform. This locomotive, then, will haul a load as heavy as 878 horses could pull at the rate of speed assumed above for them on good common roads; but as it hauls this load at an average speed of four times that of horses, it is doing the work of 3,512 horses, and is capable of doing it not merely for 10 hours per day, but for nearly the whole 24. If the horses, however, were hauling upon a level railroad instead of a common road, it would not require so many of them to do the same work. Haswell gives a table of the comparative useful effect of the power of an average horse on a turnpike, a railroad, and a canal. He rates the tractive force of the horse at 83·3 lbs., and says that a horse, traveling at the rate of $2\frac{1}{2}$ miles per hour for $11\frac{1}{2}$ hours per day, will exert a useful effect equal to 14 tons drawn 1 mile on a turnpike, 115 tons on a railroad, and 520 tons on a canal. Making the hours of work and the tractive force agree with those of Trautwine, the average horse would draw 110 tons one mile on the railroad, or for his whole distance of 25 miles in 10 hours he would draw $4\frac{1}{5}$ tons. The locomotive above described, then, draws as many tons as $331\frac{1}{3}$ horses could pull on the same railroad, and as it draws them at four times the speed of the horses, it does as much work in the same time as 1,325 horses.

The total miles of railroad included in the returns made to the Massachusetts Railroad Commissioners for 1877, adding the double track but not the sidings, is 3,124, of which 2,295 are in Massachusetts. The whole number of locomotives used by the corporations reporting as above is 1,081, and the proportion due to the miles in Massachusetts is 757. The average weight of the locomotives is not given in the report for last year; for the previous year it is given, sometimes in tons, sometimes in pounds. Supposing the tons to mean 2,000 lbs. each, 886 locomotives reported averaged 58,839 lbs. each. But we do not know how much of this was carried by the drivers, which shows the effective power of the engine. Some of the engines were tank switching engines, carrying all the weight on the drivers; some were heavy freight engines with 6, 8, or 10 drivers, and having eight or nine-tenths of their whole weight effective; but probably all the passenger engines and many of the freight engines were of the common style, carrying from $\frac{5}{6}$ to $\frac{6.5}{10.0}$ of their whole weight on the drivers. For the purpose of this calculation we will take the average weight of the engines, 58,839 lbs., and consider $\frac{8.5}{10.0}$ of it effective, *i. e.*, 38,245 lbs. An engine having this weight on the drivers should be able to haul, at an average speed of 10 miles per hour on a level road, 925 gross tons, exclusive of engine and tender. To haul this load on a good common road, at the rate of $2\frac{1}{2}$ miles per hour, would require 557 horses; to haul it at the same rate of speed the locomotive does would take four times as many, or 2,228. To haul it on a level railroad by horse power at the rate of the locomotive would require 840 horses. It is not necessary here to consider curves or grades. The engine is *capable* of doing that amount of work on a straight and level road, and exerting its full power will do what is equivalent to that on the curves and grades, though it may be with a smaller load or at less speed; and it would require the number of horses above given to do the same work which the locomotive is *capable* of doing. It is not to be forgotten also that while the horses can do this work for only 10 hours per day, the locomotive can do it for nearly the whole 24, deducting only the time necessary to take in fuel and water.

We found the number of engines proportionate to the miles in Massachusetts was 757. Of this whole number, of course, a part are in the shops for repair, and another part may be in the stalls waiting orders. I will deduct 10 per cent. of the whole number on these accounts, which will leave 682 engines constantly at work, without doubt averaging as many hours per day as was allowed for the horses, and I think it probable they average more. Now, as it would require 840 horses to do the work of an average locomotive on a level railroad, to equal these 682 engines in effective power on the railroad would require 572,880 horses; and to accomplish the same effect on a good common road would require 1,519,496 horses. It is also to be borne in mind that this calculation applies merely to the amount of freight and cars which could be hauled at a moderate rate of speed, and that it would be simply impossible for any number of horses to haul the heavy passenger trains at the rate of 40 or 50 miles per hour, which some of our locomotives are constantly doing.

The above calculation shows the number of horses requisite to do the amount of work which our locomotives are *capable* of doing. Let us now examine the returns to see how much they actually performed.

The number of tons of freight hauled one mile by the roads reporting to the Massachusetts Commissioners for the year ending Sept. 30, 1877, was 684,810,604; and the average dead weight hauled one mile as per Commissioners' table was $3\frac{444}{1000}$ tons for each ton of paying freight, making the total weight hauled one mile 2,837,855,143 tons (of 2,000 lbs. each, I suppose). In proportion to the miles of railroad in the State, the amount would be 2,084,784,748 tons. The rate of speed of freight trains is not given in the last report; in that of the previous year it varied on the different roads from 7 to 22 miles per hour, and averaged very nearly 13 miles per hour; we will suppose it the same for the last year. As 25 miles per day is the distance which the average horse can haul his load, the number of tons, freight and cars, hauled one mile will be equal to 83,391,390 tons hauled 25 miles. Assuming 350 days as the average number of working days in the year for freight trains, we shall have 238,261 tons to be moved 25 miles each day. And as the load of the average horse was put at $4\frac{1}{6}$ tons on a level railroad, it would require 54,150 horses to haul this load at their rate of speed of $2\frac{1}{2}$ miles per hour. As the locomotives haul the same load at an average of five times the speed of the horses, it would require five times as many, or 270,570 horses, to equal the effective force which the locomotives have exerted the past year in transporting freight on our railroads; and this estimate is on the supposition that the railroads were level for their whole length. To accomplish the same amount of work on good level common roads 717,655 horses would be required.

It would be desirable to know how much to add to the numbers of horses above given on account of grades and curves. But the reports since 1870 have given no returns whatever on these subjects, and those previously made were so imperfect that they could not be used as a basis for computation.

* A Paper read before the Boston Society of Civil Engineers, March 20, 1878, by Edward Appleton, C. E.

CARDING MACHINE FIRES.

RESPECTING the liability of fire occurring in or through the use of carding machines, more especially in the woolen process, it may be proper to remark that if friction matches be fed by accident or design on to cotton cards, or the first or second breaker of a mixed cotton and woolen card, a fire may be certainly expected. Fires have arisen from the ignition of waste and flyings on the floor, around the neglected ends and boxes of the under-shaft, which carries the tightening pulley for the worker belts, and also often actuates the doffer comb; but such fires could not occur if care and watchfulness were used, nor would they be at all likely to happen if improved adjustable boxes were employed.

There is much electricity evolved by the rubbing of the roving threads as they leave the front of the woolen condensing card—and to this we referred on a previous occasion in the *Review*. Much trouble and loss sometimes occur from this cause—the rovings running together and breaking—and to avoid these and dissipate the electricity some carders burn one or more open lamps, generally fed by lard oil, on each side of the front of the condenser—also sometimes in the middle of the front, and then placed directly on the floor. We are not informed whether this practice has been the direct cause of ignition, but any one can see that it is almost an invitation to such casualty, especially if coal oil be used in the lamps.—*American Exchange and Review.*

OBELISKS.*

By PROF. T. L. DONALDSON.

OBELISKS are now regarded as the most simple monuments of Egyptian architecture, and among the most interesting that antiquity has transmitted to us, from the remoteness of their origin and the doubt in which we still are as to the period when first set up. The oldest which now remains to us is still standing at Heliopolis, near Cairo—the On-Rameses or Beth-Shemesh of the Hebrew Scriptures. Abraham was unborn, the Pentateuch of Moses was not written, when the inhabitant of Heliopolis adored his gods in the temple of the sun, and read upon the obelisk, still in its place, the name of Harmachis and that of King Osirtesen, who then reigned and reared it, and to whom Mariette Bey assigns the date of 2851 years before Christ. He was a powerful Pharaoh, whom eleven royal dynasties had preceded, and who was followed by twelve more, when Alexander the Great, about 380 B. C., came to consult the oracle of Ammon, and to found at Alexandria the capital of his future Egyptian empire. Obelisks are supposed to have been principally dedicated to the sun Horus, of whom the hawk was a symbol. From earliest periods of antiquity obelisks have been regarded as remarkable monuments of the skill and perseverance of remote ages. They must ever be considered as valuable records of the ancient history of the Egyptians and of the skill of those periods, monumental evidences of their sovereigns and of their warlike exploits. Extracted with vast labor from their quarries as monoliths, conveyed six or seven hundreds of miles down the Nile, and erected with difficulty in front of their temples, they are emblems of the perseverance and love of glory of the Egyptians or their rulers. Their transport to Europe by the ancient Romans under their emperors shows the high value in which they were held by that people, as witnesses of their own world-wide victories in remote regions, and as proofs of the estimation in which they were regarded by the very conquerors of Egypt. They were granite monoliths, consisting of a square shaft gradually diminishing toward its summit up to about nine diameters high, where the faces suddenly receded up to a point, their upper portion being called a pyramidion, from the similarity of its general form to that of a pyramid, though much more rapidly sloping. There is authority for assuming that sometimes the pyramidion had a seated figure on its top, whether of the king or one of their gods. The Egyptians set great value upon the size of their monoliths, and if a large block were extracted from a quarry not quite corresponding in all its sides, whether as to size or form, they would without scruple use it for their purpose, or shape it as near as possible to the object they had in view, without diminishing its size. The consequence is that many of their obelisks, pedestals, and sarcophagi even, are irregular in shape. In like manner some of the huge blocks intended for obelisks came out of the quarries misshapen at the smaller end, and to remedy this defect they covered them with metal cappings of the required shape rather than reduce the length of the stones by cutting off the rugged portions. The summit of the Parisian obelisk was irregular in shape, and left quite rough. There was at bottom of the pyramidion a channel and fillet, then a surface setting back, and the granite presenting an uneven face. It was in the same state previous to its being lowered by the French. There must have been something to cover this unsightly appearance. An Arab writer, Mohammed, son of Abdarrahim, says that "one of the obelisks of Pharaoh which were at Mataria, near Cairo, fell down, and a great quantity of copper was taken from the top." Reference is also made by Kodhai to two obelisks in the city of Heliopolis as "being extremely wonderful. On their summits are two pointed caps in copper. When the Nile overflows, water flows from their summits from beneath the bronze coverings and descends to about the middle of the column (obelisk); this part is green." And again: "This obelisk is square, formed of a single block, pointed at the top, which is a covering of copper as yellow as gold, above which is the figure of a man sitting in his chair looking at the rising sun." Our obelisk has an inscription, translated by M. Chabas from the transcript of Burton's "Excerpta Hieroglyphica." In it is the following line: "He erected two very great obelisks, capped with gold." Mariette Bey mentions that round the lowest part of the obelisk of Hatasou runs an inscription in horizontal lines covering the whole of its four sides, which states that the summit of the obelisk was covered over with pure gold taken from the chiefs of the nation; and he observes that unless this expression simply implies an apex overlaid with a casing of gilded copper, as the top of the obelisk must have been, this inscription possibly refers to the sphere of gold (?) which is represented on certain bas-reliefs at Sakkarah. He further says: "The obelisk was, no doubt, gilded from top to bottom." In examining closely, one may notice that the hieroglyphs were carefully polished, and, moreover, that the plain surface of the monument was left comparatively rugged, from which it may be inferred that it had been covered with a coating of white stucco, as so many Egyptian monuments were, which alone received this costly embellishment of gilding, the hieroglyphs themselves retaining the original color and actual surface of granite. Dr. Birch mentions that the tombs in the Libyan range behind Gournah and El-Assasif "are full of scenes of the reign of Thothmes. Two great obelisks of 188 cubits high, with gilded tops! are recorded in these sepulchers." Mariette Bey also says that "the inscription further states that the two granite obelisks of Heliopolis were actually completed and erected in seven months from the very beginning, when first extracted from the quarry in the mountain." This use of bronze caps seems to justify the practice in modern times, as the ancient Romans possibly adopted in certain cases the same practice; and this has been handed down traditionally to our period. When the pyramidion was perfect in its shape, and required no artificial capping, it was sculptured in sunk relief, with a representation, as on the Alnwick Obelisk, of the god to whom the monument was dedicated, before whom was the king kneeling and presenting his offering, or by a group consisting principally of a sphinx on a pedestal in front of a deity seated on a throne. A very fine example of the apex of an obelisk at Karnak is to be seen in the full-sized cast of one side of a pyramidion, on the landing at the top of the staircase leading to the Egyptian Room, in the upper gallery of the British Museum. Imposing from its size and execution, it shows the bold depth of the hieroglyphs and rounded surface of the sunk character polished like the delicate carving of a gem. Passing on to consider the shaft, we may note that the sides were not always equal in their width, varying a few inches. In the exceptional instance of the obelisk of Biggeg or Crocodilopolis in the Fayoum, called by Mr. W. R. Cooper an obeliscoid monolith, the faces are 6 ft. 9 ins. broad, the sides only 4 ft. thick. Our London obelisk is at the base 7 ft. 10·3 ins. × 7 ft. 8 ins.; at the summit, 5 ft. 1·3 in. × 4 ft. 10·25 ins.—an inappreciable difference. The four sides or faces of obelisks were usually square, but occasionally they were convex—proving a nice perception for effect, as thus the light was much softer upon the surface, the shades less crude, and the angles less cutting. Whether there is in any an entasis in the upright line has not yet been precisely ascertained, but perhaps this fact may now be set at rest in respect of our Alexandrine obelisk. Usually obelisks had one, two, or three vertical lines of hieroglyphs. It may be assumed that only one central series was contemplated by the original Pharaoh, but that his son, successor, or successors added a line on each side, and it is remarkable that earlier hieroglyphs were much deeper cut than more recent ones. Occasionally some of the hieroglyphs have been altered or erased, more or less deeply cut, and the names of other gods or Pharaohs have been substituted. It is not impossible that occasionally the hollows of the hieroglyphs may have been filled in with some colored substance, as on the frescoes, the hieroglyphs painted in different colors, preserved in the Egyptian Hall of the British Museum. These inscriptions are generally trivial, recording little more than the names and patronymics of the king, his relationship to the gods, and list of his virtues and of the peoples he may have subdued in battle; sometimes with maxims and blessings of the gods. One of the inscriptions on the obelisk of St. John the Lateran, Rome, is rendered by Dr. Birch: "The Har-em-akhu, the living Sun—the strong bull crowned in Thebes—lord of diadems augmenting his kingdom—the hawk of gold—the arranger of diadems—very valiant, the King Ra-men-Kheper—approved of the Sun, son of the Sun—Thothmes (III.) has made this memorial to his father, Amen-la, lord of the seat of the upper and lower countries, has erected an obelisk to him at the gateway of the Temple in Thebes." The obelisk of Alexandria, now lying in our Thames, contains similar inscriptions. We have now to consider the dies, pedestals, and steps upon which the obelisks were anciently raised. On this subject we have very little reliable information, for the bottom portion of those now left standing in Egypt are incumbered and surrounded by huge fallen blocks of stone, preventing their full size from being ascertained; and on those transported to Constantinople or Rome or elsewhere from their original sites no reliance can be placed. Our late friend, Mr. Joseph Bonomi, may be considered a great veteran authority on the subject of obelisks, as he made it an especial object of study when in Egypt and in Rome. He described the upper part of the block of granite on which that of Karnak stands as cubical, but while on two sides the surface is vertical, on the two other sides the surface inclines very much. This divergence of the faces of the die is a remarkable confirmation of irregularities existing in large blocks of granite, from the desire to retain, as far as possible, the cubical mass entire. Mr. Bonomi also stated that "the base of the obelisk at Luxor is composed of several pieces of granite, and on the north and south sides has four statues of monkeys cut out of two or three blocks of granite *in alto rilievo*. On the east and west sides are sculptured in Egyptian *cavo rilievo* (hieroglyphs) figures of Nilus bringing in the productions of the country." This extraordinary mode of embellishing the pedestals seems almost incredible, were it not for this instance, which is illustrated and detailed by M. Le Bas, the engineer, who transported the Luxor obelisk to Paris, where, however, the original pedestal forms no part of its present composition in the Place de la Concorde. We may infer that in other cases the monoliths rested on one or more steps, and that they did not rise at once without any substructure or plinth from the level of the pavement. Sometimes bronze balls, or other supports at the angles, raised the monolith a few inches above the slab or block beneath. Mr. Dixon discovered an inscription engraved in Greek and Latin on the bronze crabs supporting the standing obelisk of Alexandria, having the words "Anno VIII. Cæsaris, Barbarus Præfectus Ægypti posuit; Architectore Pontio." This explains the reason why some of the obelisks at Rome have the like angular supports.

The erections on the banks of the Nile were constructed of the sand and limestones extracted from the quarries near. The pink granite was only used for the obelisks, statues, sarcophagi, casings of the pyramids, sanctuaries in temples and linings of some special tombs, and for other precious or sacred purposes. The position of the quarries of Syene must have been of the utmost importance in facilitating the application of that fine material. Situate below the rapids, or so-called cataracts, when once the masses were extracted from their beds, no obstruction presented itself in their course down the river to their destination, whether to Memphis, Heliopolis, or the Delta. Mr. W. R. Cooper states that twenty-seven of the forty-two now known were from Syene, and they are doubtless the largest. An unextracted block still remains at Syene, 95 ft. long by a diameter of 11 ft., with the quarrymen's marks upon it. Sir Gardner Wilkinson mentions that the final operation of extraction, when three sides of a mass had been worked round, was by cutting a groove or channel about a couple of inches in depth, and kindling a fire along its whole length. When the stone was intensely heated, cold water was poured into the groove, and the block detached itself with a clear fracture. Wedges of wood were also inserted, saturated with water, then exposed to heat, and the expansion rent the mass asunder. Thus detached, it was drawn down to the river, where it was encased, or upon a galley or raft floated down the Nile to near the spot where it was ultimately to be set up. From the river bank it was hauled to the propyla in front of which it was to be erected as shown on the illustration before you, representing in a sculpture on the wall of a hypogee at Beni-hassan the transport of a colossal statue. One at Gournah measured 57 ft. 5 ins. high, and, according to Mariette, weighed not less than 1,198 tons! The colossus on the illustration exhibited is supposed to be about 20 ft. high, and the monolithic block rests on a species of sledge or cradle, to which it is securely fixed by cables. There are four lines of 86 men hauling the load with cables; the men are in couples. In the front part of the statue, standing at its feet, is a man pouring water upon the ropes to prevent their chafing and catching fire by friction. On the knee is a man with outstretched arms beating time with his hands that the efforts and action of the haulers might be uniform. At top are six companies of soldiers of ten to each company, carrying in one extended hand a palm branch, in the other a club. Beneath the cradle or sledge of the statue are three water-carriers with their jugs and three men carrying blocks, and three officers with wands. Behind the statue are three other rows of men—twelve in all—to act as relays. Under the sledge there is no appearance of rollers. We have no hieroglyphs or painting on the walls of the pyla, or tombs, showing how the obelisks were raised and placed in their final position. That the erection of the monolith on its pedestal was a most critical operation is sufficiently obvious, and its difficulty is illustrated by an anecdote related by Pliny: Rameses erected an obelisk 140 cubits high, and of prodigious thickness. It is said 120,000 men were employed on the work. To insure the safety of the operation by the extremest skill of the architect, his own son was fastened to the summit while it was raised. But on a small illustration before you there is represented a mural painting in a hypogee or underground tomb at Gournah, with three men polishing a column of no great size. The column rests on blocks; the polishers are astride or seated on the column with rubbers rubbing the surface. Another from the same tomb shows a colossal upright figure surrounded by scaffold poles; five artisans are chiseling, rubbing, and polishing the surface. Another small illustration represents a mason carving a many-colored sphinx; he is chiseling the paw of the animal; he has a wooden mallet in his right hand, and in his left a steel chisel, unmistakably indicated by the deep blue color of the tool. I have not yet alluded to the masons' and carvers' operations of cutting the hard materials used in their obelisks, statues, sarcophagi, etc., such as the pink and black granite, black marble, basalt, etc. Hardly any iron tools have been preserved among the relics of the tombs. With what materials did the ancient Egyptians carve with such refined delicacy and exquisite sharpness the mouth, eyes, and other features of their statues, or what Mr. Erasmus Wilson calls the gem-like surface of the *in cavo relievo* of the hieroglyphs? I do not know that we are possessed of any process by which brass may be sufficiently hardened for the purpose, and we have not specimens enough which have survived the oxidation of the iron to satisfy us on the point as to that material. Could they prepare and soften the surface by some chemical application on the harder elements of their hard stones? No one has yet been able to inform us; but the mystery of the execution of the Egyptian sculpture still evades our wonder and excites admiration of their skill. Our own granite merchants have achieved wonders, by means of steam machinery, in working out by rotary motion the shafts and bases and caps of certain columns and circular pedestals, but the refined sharpness of the lips, eyebrows, and other delicate features of the Egyptian heads, as they appear even upon the lids of the sarcophagi, or the busts in the British Museum, has yet to be attained. The sides of an obelisk rarely corresponded exactly with the breadth of its face, or the height of the shaft to any fixed relation with the width at the base, and there is a like disregard in the height of the pyramidion, which, however, was high-peaked and never stunted. Nevertheless, the shaft varied from eight to nine diameters high up to the pyramidion, which itself was from sixty to seventy-five-hundredths of the breadth at the base. Too few of the pedestals, plinths, or steps have been ascertained or measured to afford any general law of proportion whether as to their breadth or height. The positions of obelisks were before the gigantic pylons, which formed the entrance gateways to the forecourts of their temples, and they were, without exception, in pairs.

At Karnak the situation of the two lofty ones erected by Queen Hatasou (one of which still stands, and is 108 ft. 6 ins. high, the loftiest one known) was between two lofty pylons only 40 ft. or 50 ft. apart! Those in front of the outer pylon are not so distant in advance of it. Consequently the Egyptians disregarded the immediate proximity of a lofty wall, backing them up, and none are known situate in wide open spaces. Various objects occupied the approaches to the temples, and formed an assemblage calculated to impress with awe the dignity of the fane of their god. The sacred way led up from the river, flanked on each side with variously-headed sphinxes. At Karnak the dromos is one mile and one-third long, with a line of sphinxes on each side. Approaching nearer, the worshiper finds two obelisks on the right and left not necessarily of the same height. At Luxor one is 7 ft. or 8 ft. higher than the other, and to diminish the appearance of disparity in size the shorter one is raised on a lofty pedestal and brought some feet in advance of its companion. Attached to the face of the pylon are six sedent gigantic statues of kings, majestic as to size, and seated in the hieratic posture. Lofty colored poles, similar to the standards at Venice, are inserted in sinkings chased into the walls, surmounted with the expanded banners of the kings or heraldic bearings of the temple floating in the wind. The pylon itself, perhaps 200 ft. wide and 100 ft. high, forms the background of the whole, crowned by its cavetto cornice, and its surface covered with colored sculptures of the victorious Rameses in his chariot, with upraised arm slaying his enemies, trampling them under his horses' hoofs, and alone dispersing them in flight—a grand scene of one of the dramas in the reign of a victorious monarch. In the center of the structure is the portal, 56 ft. high, and through it the sacred or triumphal procession passes in all its gorgeous majesty to within the sacred precincts, there to observe the ritual ceremonials of the mysterious Egyptian cult of one or more of their eight great divinities or animal gods.

Having thus given a slight sketch of the architectural magnificence of the Egyptians, allow me to offer a tribute of respect to a brother architect. His name, as given by Mariette Bey, is inscribed on the Temple of Edfou. It was Ei-em-hotep Oer-si-Phtah-Imouthes, the great son of Phtah, the only one yet discovered on the monuments of Egypt. I am afraid we are too late for its insertion in the colossal architectural dictionary of our times, unless it finds its way into an appendix. The chronology of the Bible, as assumed by some learned men, gives the age of the world before the Christian era as 4,004 years. Mariette Bey, under reservation, founding the calculations upon dates afforded by inscriptions upon tombs, temples, obelisks, and other monuments, gives the date of the Egyptian empire alone and its dynasties as 5,004. Bunsen assumes a still remoter period, and Lesueur, our honorary and corresponding member, in his chronology, "Les Rois d'Egypte," commences with 20,000, which latter is to be considered as an imaginary datum, from which to start in computing the history of the world. But adopting Mariette Bey's comparatively moderate number of 5004 B. C. for the beginning of the Thinite dynasty, as the historic date of the commencement of Egypt's national existence, it fills one with wonder when we consider how many gaps occur in the continuous rule of Egypt's autonomy. How could the very existence of her nationality and arts be maintained, even with periods of more or less purity, when we know that for about 1,200 years, or nearly one-fourth of her existence, she was at various times ruled and overrun by the Hykshos or Shepherds, the Ethiopians and the Persians, under Cambyses, Darius, Xerxes? At last she was conquered, and ruled for 332 of those years by the Greeks, and Romans from the time of Alexander and his successors to that of the Romans. Could any other people, under such crushing circumstances, have maintained their identity on their own native soil?

* Obelisks, their Purpose, Proportions, Material, and Position. A paper read at the Royal Institute of British Architects, April 8, 1878.

The arrival and erection of the Alexandrine obelisk among us may produce very notable results in regard to our knowledge of ancient Egyptian history, and connected as it is with our Bible. The old Greeks and Romans, the classics of our boyhood, have had their annals duly chronicled and reduced to elaborate histories by the learned. These, it is true, have been turned upside down by recent erudite inquiries, substituting a different and new chronology and an assumed rational statement of facts. Egypt till very recently had no consecutive accepted history in our language, that I know of, until our learned Dr. Birch, of the British Museum, compiled for the Christian Knowledge Society his summary of the ancient history of Egypt from the monuments (one of a series), putting together with vast knowledge and most critical acumen an admirable history. There cannot be a doubt that our countrymen, as they pass by our obelisk, will have their curiosity excited by the sight of hieroglyphs which may have been seen and read by the Jews at the time of Moses or when our Saviour was taken by his parents to Egypt as a place of refuge from Herod's rage. They will seek in Dr. Birch's book the solution of the mysteries revealed in those enigmatical sculptures and the history of that ancient people.

ON BLEACHING SHELLAC.

By JOSEF MARIA EDER.

THE greater part of the colorless shellac which is used is bleached in the alcohol solution, because these varnishes give a good polish, and warrant that the metallic articles covered with them will remain bright. There are, however, in the market considerable quantities of solid bleached shellac, and its practical preparation is not unimportant.

The method of bleaching with alcohol and chloride of lime, given by Field in the *Polytechnisches Notizblatt* (1852, li., p. 23), and by Wittstein in *Dingler's Journal* (1857, CXIII., 467), as well as those of Lunning and Elsner, with alcohol and animal charcoal, are not applicable to solid shellac, owing to the high price of alcohol and the difficulty of its recovery. Kressler's method is more practical, in which the shellac is dissolved in aqueous soda solution, and bleached with hypochlorite of soda. Sauerwein modified Kressler's process by the addition of sulphite of soda to the above named reagents.

According to my experiments the following process is practically especially to be recommended, and can also be carried out on a large scale, according to my directions:

Ten parts of pulverized shellac dissolved with four parts of crystallized soda in 120 to 150 parts of hot water in a copper kettle, and the violet solution, the color of which is due, according to Marquart and Nees Von Esenbeck, to a coloring substance similar to carmine, is filtered through linen into a wooden vat. Ten parts of chloride of lime (containing about 30 per cent. chlorine) is triturated with a solution of 10 to 20 parts of crystallized soda in 200 of water, and this bleaching solution filtered into the shellac solution. To the mixture, when cold, dilute hydrochloric acid is added carefully until some shellac begins to separate in crumbs: in most cases only a very little acid is required. This little dodge—suggested by Sauerwein, in fact—hastens the bleaching in no small degree. After two or three days, whether the solution is kept in the dark or in the light, the bleaching is finished. The shellac is then precipitated by the addition of concentrated hydrochloric acid.

If a comparatively pure natural shellac is to be bleached, this white crumbly precipitate is at once collected upon coarse linen, thoroughly washed with frequent stirring, and then melted together. Impure shellac is left standing for several hours in the liquid, after having been precipitated with hydrochloric acid. The liberated chlorine acts very energetically; yet it is preferable to allow the bleaching to proceed in the alkaline solution. The finely divided shellac, if it remains very long in the acid chlorine solution, becomes brittle, and cannot be drawn out so well. Inferior grades of bleached shellac are obtained by using half the quantity of chloride of lime above prescribed.

The precipitated shellac is put into boiling water, when it becomes soft, and can be moulded in any desired form. At first it is porous and not transparent, but repeated warming, and strong kneading and pulling, impart to it a beautiful silky gloss. In spite of the greatest cleanliness, which is absolutely necessary, it is scarcely possible to prevent the surface becoming yellowish; if the bleaching does not succeed perfectly, the whole mass has a yellowish shade. To improve the appearance of the ware, the drawn and moulded shellac is put for some twenty-four hours in the acid chlorine liquid, from which the precipitated shellac has been strained out. It is used before being diluted by the wash water: if necessary some more chloride of lime is added. By this means a chalk white surface is obtained. This white layer also possesses this advantage, that the shellac can be kept a long time without changing its appearance; for it does not change, as all bleached shellac will, and that, too, throughout the whole mass. Finally, the silky luster is greatly enhanced by brushing the surface. This silky appearance cannot be obtained by chemical means. According to Berzelius, by a short immersion in strong ammonia the surface swells, and when dry has a strong luster, but instead of being silky it is resinous. The white color of product changes under this treatment to yellowish, and cannot be restored by the above mentioned process of after-bleaching.

The shellac thus prepared dissolves rapidly in alcohol, and the solution is perfectly colorless. Previous swelling of the shellac in ether is superfluous. With freshly bleached shellac a milky turbid varnish is frequently obtained, which does not clear on standing a long time, as observed by Jacobsen and Peltz. The cause of this is the insolubility in alcohol of a resin which is contaminated in the crude shellac, as shown by Unverdorben (*Pogg. Annalen*, XIV., 119), and by the wax in the shellac (*Ann. Pharm.*, CXXXI., 286). The method proposed by Peltz, of extracting this substance with petroleum ether, I do not consider commendable, for the reason that such varnish dries brittle. Shaking the solution with pulverized chalk, or gypsum, accomplishes the clarification in a few hours, and the clear solution can readily be drawn off—*Dingler's Journal*.

PLASTER CASTS OF FISH.

FISH are taken as fresh and perfect as possible, wiped with a cloth, not only to dry the moisture, but to remove the mucous secretions. The fish is then laid on a flat smooth board, and placed in a natural position by means of little lumps or wedges of potter's clay, raising the parts liable to drop below the axis of the fish. The fins are spread out upon flat cushions made of potter's clay, and are kept in their spread position by means of pins. When the fish has been firmly set in a natural position a rather thin mixture of plaster of Paris and water is poured over the fish, and repeated coatings of this material are applied until a sufficient thickness is attained, when it is allowed to set moderately hard. The mould is now turned over and the fish removed. When the cast is made, a slight coating of shellac varnish is applied throughout the inside of the mould. The plaster of Paris mixture is then poured in, and when sufficiently "set" the mould is chiseled away, the shellac coat guiding the workman as to the depth it is safe to cut. The cast is now trimmed of its rough edges and projections, and a square stiff frame having been made, with the inner edges studded with nails, the cast is placed within it, lying on a flat table, and plaster of Paris is then poured within the frame until it rises to the level of the edges. Embracing the base of the cast, it also adheres firmly to the inside of the frame, and when "set" is lifted from the table. The plaster matrix, which now becomes the back of the fish, is smoothed. The plaster cast is now ready for coloring.

NEW PHOTO-PLATE PROCESS.

AT a recent meeting of the Société Photographie, M. Poitevin made a very interesting communication on a property of gelatine, rendered insoluble by heating with iron perchloride and tartaric acid, of becoming again soluble after a sufficiently long exposure under a photographic negative. He has also experimented on and proved the possibility of obtaining a print in fatty ink on polished glass coated only with a dry film of iron perchloride and tartaric acid, or on gelatine previously rendered insoluble, the ink adhering only to those parts which have not been insolated. The solvent penetrates from the surface inward, and by adding an inert or grainy substance to the gelatine the required kind of grain for impressing ink or soft metal plates is easily obtained.

M. Poitevin avails himself of the newly-discovered property of gelatine films which have been rendered insoluble by perchloride of iron and tartaric acid to obtain directly from a negative, by means of a fatty ink, positive prints which can either be transferred to a lithographic stone, or to a zinc plate, from which an impression can be taken by the printing-press, or which can be rendered in relief by the recognized methods of typography. This property consists in the fact that gelatine made insoluble by iron perchloride and tartaric acid, and not again rendered soluble by exposure to light beneath a photographic negative, will once more become exceedingly soluble in warm and slightly acid water, either after the image has been developed or when it has been previously treated with a weak solution of hydrochloric acid.

The process adopted by M. Poitevin for producing, in this novel way, pictures in fatty ink, is as follows:—The paper is coated on one side only with gelatine, slightly colored in order that the progress of the operation may be the better observed, and floated with both ends successively on a bath prepared by dissolving—

Iron perchloride	10 parts.
Tartaric acid	3 "
Water	100 "

Or the paper may be dipped entirely in the bath for some minutes. It is then hung up by one corner in the dark to dry. When it is dry, it is exposed to the sunlight under a negative of which a print is to be reproduced. The printed film is next treated with warm water, which dissolves out all the parts that have been affected by light; thus is obtained a reversed negative print of the object, since all the transparent parts of the negative are represented on it by the white of the paper, where it has been bared of gelatine. By means of a roller, or of a pad, or, still better, of the press, the surface of this print is then coated with a film of ink, and plunged in water slightly acidulated; it can also be next treated with acid water, which dissolves the gelatine where it still remains on the white parts, while that which is in direct contact with the paper remains adherent to it, and forms a positive picture in fatty ink which can be transferred to the stone or the zinc. M. Boivin, M. Poitevin's fellow-worker, in experimenting with this new process, has obtained by its means excellent results.

DRY-PLATE PRIZE.

THE following are the conditions prepared by a committee of the London Photographic Society, consisting of Messrs. W. England, Sebastian Davis, and Wm. Bedford, and sanctioned by Mr. Paget, the donor of the prize, for the guidance of competitors for the prize of £50 offered for the best dry plate process:

"1. The description of each process accepted in competition shall contain sufficiently accurate details to enable any ordinarily skillful photographer to produce results thereby equal to those obtainable by the wet collodion process.

"2. Sensitive films made by the process shall remain without perceptible change for not less than four months after preparation, and must keep satisfactorily three months in any climate between exposure and development. Should more processes than one fulfill the stated conditions, the preference will be given to the most sensitive and easily prepared.

"3. Each competitor or his representative shall have the option and be willing, if required, to prepare any special chemicals or appliances, and, with such or others prepared according to his formulæ, make, expose, and develop some negatives by his process, in the presence of the appointed judges.

"4. A description of the processes shall be sent to the secretary of an award committee, to be appointed by the Council of the Photographic Society of Great Britain (competitors not being eligible to act thereon), on or before the 31st March, 1879, accompanied with three 8½ by 6½ unexposed plates, and two or more finished negatives. Should the negatives not be equal in the opinion of the judges to those produced by the wet collodion process, they, together with the unexposed films, and descriptions of the means by which they have been produced, will be returned on or before the last day of May, 1879. Competitors may send the negatives, etc., accompanied with their names and addresses inclosed in a sealed envelope, and marked outside with a cipher and an address, which will be returned unopened should the award committee consider the specimen negatives below the requisite standard of excellence. One or more of the negatives by the successful process shall be retained for exhibition until after the next meeting of the Society.

"5. The decision of the committee appointed by the Council of the Photographic Society shall be accepted by the competitors as final, and the receipt of the prize shall be deemed equivalent to an agreement that the process may afterward be published unconditionally, and practiced by any one. Should the conditions not be entirely realized, the prize may be either awarded or retained for competition during the following year, at the discretion of the judges. After the award the description of the prize and other processes may be published under the direction of the judges, unless a wish be expressed to the contrary at the time of sending in a process for competition, should it not prove the successful one."

MECHANICAL AIDS TO HUMAN LOCOMOTION.

WE have been favored recently with several discussions by correspondents on the subject of animal mechanism, the particular topic being the advantages gained by the use of the velocipede in traveling. Several writers virtually take the position that as by no merely mechanical contrivance can energy be augmented, therefore a man can in a given period certainly gain nothing by sitting astride a bicycle and propelling himself; and they further hold that it is an error to assert that there is any real advantage to be secured by the velocipede over simple progression afoot. This question, it will be evident, brings in the whole subject of human locomotion and the means whereby the same is assisted—and these means are the velocipede, the skate (ice or roller), the snow shoe, the oar, and the stilt. By any of these mechanical devices, in connection with himself as the motor, a man can propel himself from place to place with greater rapidity than he can do the same by means of his unaided members.

In England recently a distance of 20 miles was traveled on a velocipede in a few seconds less than an hour. Cases are on record where a man has skated 1½ mile in 3 minutes and 6 seconds. Snow shoe traveling has been done at the rate of 4 miles in 24 minutes and 6 seconds; and it has been estimated that in rowing a boat 1 mile in 7 minutes, the oarsman performs the labor of 6 fully worked laborers at ordinary occupations of 10 hours. As it is manifestly impossible for the human body, without mechanical aid, to accomplish any of the above feats, the question arises of how does the oar, the bicycle, the snow shoe, the skate, or the stilt augment the capabilities of the human machine.

The general signification of the word "work" is the overcoming of resistance. The accepted unit of work is the raising of one pound of matter one foot high, the resistance being the attraction of gravitation. Motion is not work, neither is the weight of one pound drawn horizontally the unit of work, unless frictional resistance should happen to equal the weight. When we speak of power, time becomes a necessary element, and the unit of power refers to a certain weight raised a certain distance in a certain time.

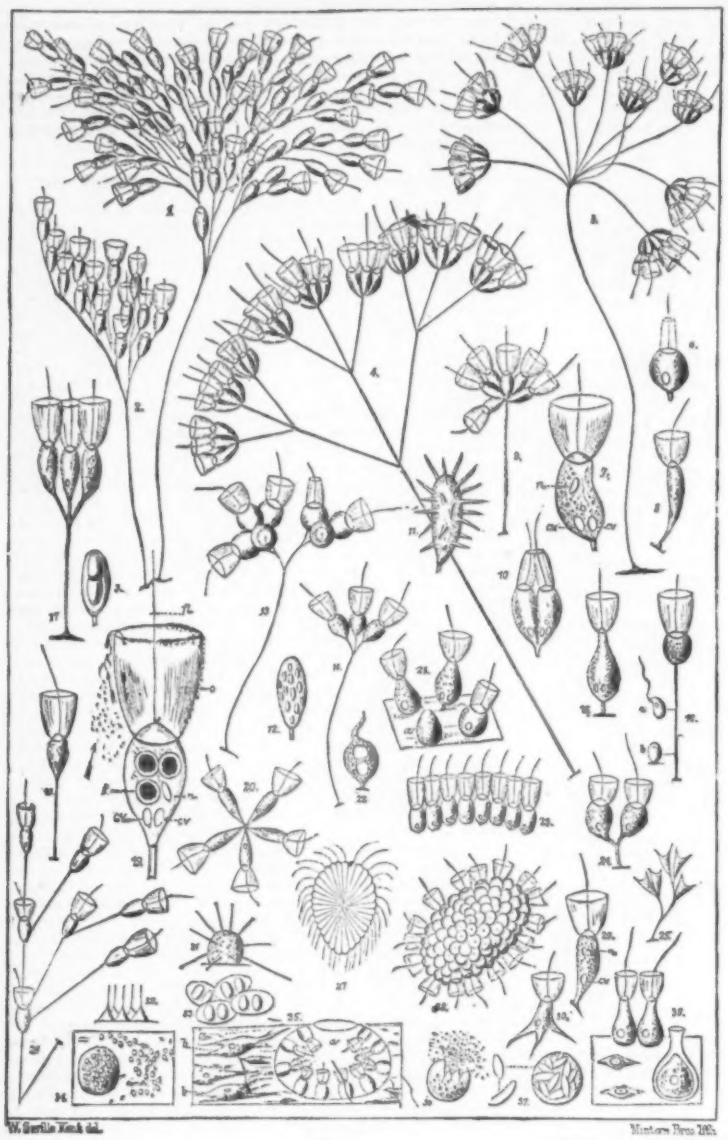
The human body as a machine is the most perfect mechanical contrivance ever made. Not only does it convert a far greater portion of the energy evolved into mechanical work, but it distributes this work over a great multiplicity of objects. For present purposes we are to consider only muscular work, which may be conveniently divided into two classes, namely, the work of muscles governed and those not governed by the will. The last include the beating of the heart and other movements absolutely necessary to life, and hence, providentially, placed beyond our control. The first may be again subdivided into voluntary and semi-voluntary actions. Voluntary action is that which results immediately from exercise of the will, as the movement of the hand in writing. Semi-voluntary action is the result partly of natural instinct, partly of education. In higher animals the latter element enters to a greater degree than in those of lower orders. A chicken shortly after being hatched will run around; an infant must be taught to walk, and its command over the muscles which keep its body erect, at first the direct result of the will, as age advances continues with little or no exercise of will power. The labor of the muscles in sustaining the body in any position is therefore one form of muscular work; that of changing the body or any of its members from one position to another is a second form. Exhaustion results from an overplus of either. It is impossible, for example, to hold the arm extended horizontally beyond a limited number of minutes. Severe fatigue follows standing in one position for a few hours; and generally it may be noticed, as a curious fact peculiar to all organisms possessing locomotive powers, that constant change of position is necessary to their well-being, and that in reality they never rest. Rest with them, as in all nature, is merely a relative term. Locomotion is as resting to the body fatigued with remaining sedentary as the converse.

In realizing, therefore, that two kinds of work are always in progress, it follows that the element of time is a most important consideration, because exhaustion has reference to the time in which the muscles are acting, as well as to the intensity of the force exerted. It is obvious, consequently, that to diminish either is to decrease the work necessary for a given object, and that there may be often a great saving of power in doing work quickly, although with a little more exertion during the time. If two men of equal weight ascend the same stair, one taking but a minute to reach the top and the other four minutes, it will cost the first but a little more than the fourth part of the fatigue which it costs the second, because the time in which the muscles are acting is shortened. For this reason horses are sometimes spared by being made to trot quickly up a short hill and being then allowed to go more slowly, so as to rest at the top.

It will be evident now that this saving of strength by reducing time has a direct bearing upon the question of animal locomotion with which we set out. This will be clearer when we consider that passage over space is the end in view, and that, if we undertake to reduce time by increasing velocity, the space traversed augments not directly as the latter, but as its square. A rifle ball shot vertically up with a velocity of 120 feet a second will not reach three times but nine times as far as with a velocity of 40 feet a second. Mechanical means, therefore, which augment velocity are those which are strength saving as aids to locomotion.

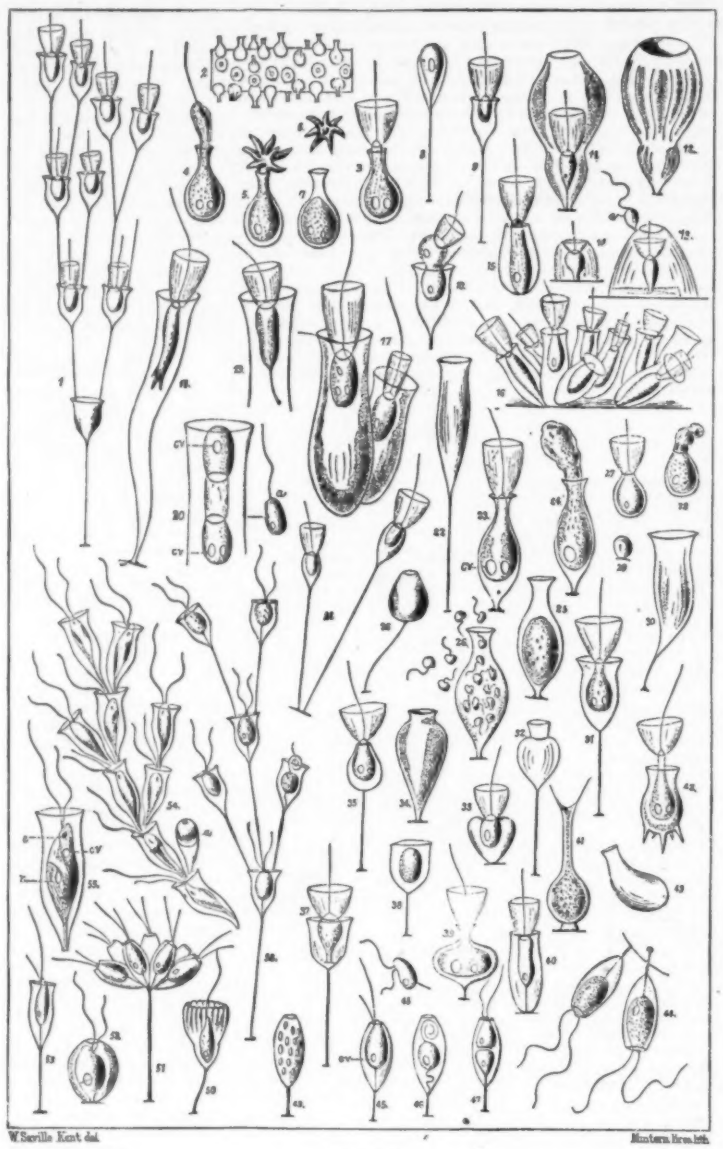
In the velocipede the large muscles of the thighs and those which connect the thighs with the trunk are chiefly brought into action to rotate a wheel of large diameter, which traverses a great space of ground in a short time. By means of the skate and snow shoe the friction between the surface of the foot and the ice is so far reduced that the energy required to swing the leg forward is sufficient to carry the whole body ahead for a distance very much in excess of that passed over by the ordinary step. The velocity is thus greatly augmented, and consequently so is the distance traversed. The oar, by its length and leverage, enables increased velocity to be gained; so does the stilt by its augmentation of the swing of the leg pendulum.

Man, as he now is, is the product of evolution; to ask why he is not otherwise than he is, is simply to ask why his environment and descent were not different, and to question the working of the Unknowable.



W. Saville Kent del. Mintorn Bros. lith.

PLATE 1.



W Saville Kent del. Mintorn Bros. lith.

PLATE 2.

FLAGELLATE PROTOZOA.

EXPLANATION OF PLATES.

With one or two exceptions all the figures in the accompanying plates represent the objects delineated as seen with a magnifying power of from 500 to 2,000 diameters.

PLATE 1.

FIG. 1, 2. Adult colonies of *Codosiga cymosa*, Sav. Kent.
" 3. A single monad of the same species in an encysted state.
" 4. Adult colony of *Codosiga umbellata*, S. K.
" 5. Adult colony of *Codosiga elloides*, S. K.
" 6. A single monad of the same with the body and collar retracted.
" 7. Monad of the same species in its fully expanded state.
" 8. Adult individual of the solitary form *Monosiga angustata*, S. K.
" 9. Adult colony of *Codosiga pulcherrima*, J. Clk.
" 10. A monad of the above dividing by longitudinal fission.
" 11. A monad of the same species, with the collar and flagellum withdrawn, emitting pseudopodic processes.
" 12. An encysted monad of the same species with the body broken up into spores.
" 13. An adult colony of *Codosiga grossulariata*, S. K.
" 14. An adult colony of *Codosiga pyriformis*, S. K.
" 15. Single individual of *Monosiga brevipes*, S. K.
" 16. *Monosiga globularis*, S. K., showing at *a* and *b* free-swimming and attached larval forms.
" 17. Adult colony of *Codosiga candelabrum*, S. K.
" 18. Single individual of *Monosiga gracilis*, S. K.
" 19. Body of the same still further enlarged and diagrammatically illustrating the feeding process described at p. 2005. The arrows indicate the direction of the current caused by the rotatory motion of the flagellum and the course taken by the food particles on striking against and adhering to the collar. *fl.* Flagellum. *c.* Collar. *n.* Nucleus. *f.* Food-particles. *cv.* Contractile vesicles.
" 20. Free-floating colony of *Astrosiga disjuncta*, S. K.
" 21. Four monads of *Monosiga consociatum*, S. K.: at *a* an individual in a quiescent or encysted state.
" 22. An individual of the same species assuming an amœboid form and exhibiting extensive internal vacuolation.
" 23. Adult free-floating colony of eight monads of *Desmarella moniliformis*, S. K.
" 24. Colony of two individuals of *Codosiga furcata*, S. K.
" 25. Animalcule figured by Stein as probably the young of *Operularia nutans*, but probably identical with the above species.
" 26. Abnormal colony form of *Codosiga cymosa*, S. K.
" 27. Free-swimming multiple-fission gemmule of a calcareous sponge, *Sycon ciliatum*, in diagrammatic longitudinal section.
" 28. A more advanced stage of the above, in which the separate flagellate cells have acquired the characteristic collars of the adult sponge-monads.
FIG. 29. An adult sponge-monad of *Grantia compressa* in its normally expanded state. *n.* Nucleus. *cv.* Contractile vesicle.
" 30. A collar-bearing monad from the same sponge emitting pseudopodic processes from its posterior extremity.
" 31. A monad from the same sponge with the collar and flagellum withdrawn assuming an *Acineta*-phase.
" 32. Initial or mono-flagellate larval condition of a siliceous sponge, *Halichondria*.
" 33. Sporocysts of a siliceous sponge, *Halichondria*.
" 34. Portion of syncytium of a calcareous sponge, *Leucosolenia botryoides*, having imbedded in its substance a sporocyst containing spores, and also free spores recently liberated from a similar cyst.
" 35. Section through a monad-chamber or "ampullaceous sac" with its contained collar-bearing monads, and portion of the syncytium of a siliceous sponge. *a.* Ampullaceous sac. *b.* Amœboid particles or cytoblasts.
" 36. Sporocyst of a species of *Halichondria* bursting and liberating its contained spores.
" 37. Sporocyst and liberated spores of another siliceous sponge.
" 38. Fragment of the cavity-lining of *Gastrophysema dithalamium* (Hæckel), one of the simplest known sponge forms; showing two collar-bearing monads, two larval or amœboid cytoblasts, and a flask-shaped sporocyst, copied from Prof. Hæckel's illustrations of the species.

PLATE 2.

FIG. 1. Adult colony-form of *Polynœca dichotoma*, S. K.
" 2. Colony of numerous individuals of *Salpingœca amphoridium*, J. Clk., attached to a confervoid filament.
" 3. A single individual of the same species in its normal and fully expanded state.
" 4. Monad with collar withdrawn but flagellum remaining, and protruding a portion of its body-sarcode from the orifice of its lorica.
" 5. Monad with collar and flagellum withdrawn, and the body-sarcode protruded as lobate pseudopodic processes.
" 6. The protruded portion of the above detached in the form of a minute stellate amœba.
" 7. The quiescent or encysted condition of the same species.
" 8. *Salpingœca inquillata*, S. K., larval form in the act of constructing its lorica.
" 9. Adult individual of the same species.
" 10. An individual of the same species multiplying by transverse fission.
" 11. *Salpingœca ampulla*, S. K.
" 12. Deserted lorica of the same species exhibiting fluted markings.
" 13. An early phase of the same species in which the lorica is as yet only in a mucilaginous condition; the uniflagellate monad, marked *a*, adherent to the top left-hand corner of this sheath, is a larval form of the same species.
FIG. 14. The same larval form represented at 13*a*, commencing the construction of its lorica by a process of exudation.
" 15. *Salpingœca cylindrica*, S. K.
" 16. Sociable colony of *Salpingœca tuba*, S. K.
" 17. Two monads of *Salpingœca gracilis*, J. Clk.
" 18. *Salpingœca cornuta*, S. K., the monad adherent to its lorica posteriorly by three pseudopodic prolongations.
" 19. Another monad of the same species adherent to its lorica by a single and elastic pedicelliform extension of its body substance.
" 20. An individual of *Salpingœca gracilis*, J. Clk., dividing into two by transverse fission; at *a* the separated anterior half swimming off as a simple uniflagellate monad.
" 21. Two individuals of *Salpingœca longipes*, S. K.
" 22. Empty lorica of *Salpingœca teres*, S. K.
" 23. *Salpingœca fusiformis*, S. K., in its normal and fully expanded state.
" 24–26. Three developmental conditions of the same species illustrating respectively the amœboid, encysted, and sporuliferous phases.
" 27, 28. *Salpingœca minuta*, S. K., in its normal and amœboid phases.
" 29. Early or larval condition of the same species.
" 30. Empty lorica of *Salpingœca curvipes*, S. K.
" 31. *Salpingœca ringens*, S. K.
" 32. *Salpingœca ureeolata*, S. K.
" 33. *Salpingœca pyxidium*, S. K.
" 34. *Salpingœca amphora*, S. K.
" 35, 36. *Salpingœca marina*, J. Clk.
" 37. *Salpingœca tintinnabulum*, S. K.
" 38. Encysted condition of the same species.
" 39. *Salpingœca napiformis*, S. K.
" 40. *Salpingœca petiolata*, S. K.
" 41. *Salpingœca Carteri*, S. K.
" 42. *Lagenella cuspidata*, S. K.
" 43. *Salpingœca Wallichi*, S. K.
" 44. Two individuals of *Bicosœca socialis*, S. K.
" 45. *Bicosœca lacustris*, J. Clk., in its normally extended state.
" 46. The same withdrawn within its lorica.
" 47. The same species dividing by transverse fission.
" 48. Free-swimming product of the above process of transverse fission.
" 49. Spore-condition of *Bicœsœca lacustris*
" 50. *Codonœca costata*, J. Clk.
" 51. *Dinobryon epistyloides*, S. K.
" 52. *Bicosœca bulla*, S. K.
" 53. *Bicosœca gracilipes*, J. Clk.
" 54. *Dinobryon sertularia* (Ehr.), a compound colony of eleven individuals showing at *a* the method of gemmation.
" 55. A single individual of the above further enlarged. *n.* Nucleus. *e.* Eyespeck. *cv.* Contractile vesicle.
" 56. A compound colony of *Dinobryon petiolatum*, Duj.

[POPULAR SCIENCE REVIEW.]

A NEW FIELD FOR THE MICROSCOPIST.

By W. SAVILLE KENT, F.L.S., F.Z.S., F.R.M.S.

IN no department of mechanical science, probably, during the last few years, has the march of progress been productive of more conspicuous and substantial fruits than in that one associated with the construction and perfection of the higher magnifying powers of the compound microscope. It is but a short while, indeed, since an amplification of some 500 linear diameters was about the utmost that could be safely relied upon by the microscopist for the accurate interpretation of independent minute organisms, or for investigating the ultimate structure of more highly complex tissues. Now, however, thanks to the mechanical and scientific skill of both English and foreign manufacturers specially devoted to this branch of optics, our range of vision among the atomic elements of this wondrous world has been extended to an almost incredible degree. A magnifying power of 2,000 or 3,000 diameters is in these days at the disposal of the merest tyro, while Messrs. Powell & Lealand, the opticians of this country to whom the palm of merit for the construction of object-glasses of the highest magnification is almost universally accorded, are able to produce a lens yielding with their deepest eyepiece an amplification of no less than 15,000 linear. To work successfully with a one-fiftieth inch objective and No. 5 eyepiece, the combination giving this marvelous magnification, or, indeed, to see anything with such a glass, belongs, as might be anticipated, to the professional expert only. A one-sixteenth objective, however, capable of yielding the more moderate but still considerably advanced amount of magnification previously named, is at the present date as accessible from a pecuniary point, and after a little practice is as convenient to work with, as an ordinary one-quarter inch glass of the best construction.

It would be a matter for congratulation if we could place on record side by side with this attestation to the mechanical perfection and improvements of our magnifying instruments, evidence of an equivalent amount of progress achieved by microscopic workers in those new fields for investigation thrown open to them by the skill of the optician. With humiliation it is, however, necessary to admit that these new and high-class magnifying powers, distributed as they now are broadcast throughout the land, are destined in the majority of instances to fulfill a most unimportant if not ignoble *role*. Boxed up in the cabinet of their possessor, they rarely see the light, except, maybe, for the purpose of a more often than otherwise abortive attempt to resolve the dots or striæ upon the siliceous shell of some obscure and vexatious diatom, further weighted or handicapped in many instances by immersion in a medium intentionally employed for the purpose of rendering previous obscurity still more obscure; or again, perhaps, for an exposition of the owner's views of the nature of the markings upon a Podura scale, or for an attempted solution of some occult question of angular aperture. Granted that the accomplishment of such trivial ends, and the emulation entertained among amateur microscopists to possess a lens that shall outstrip their neighbors' in the perfection of its defining power, has contributed in no small degree toward the highest triumphs of the optician in this department, it is still greatly to be deplored that so much latent power of discovery should thus lie, year after year, like the golden talent of tradition, buried in a napkin. Surely, among the myriads of minute organisms at the base of the animal and vegetable worlds there is room enough and to spare for valuable and even original investigation! Here, indeed, the harvest-field is full to the overflowing, and to any entering upon it in a scientific spirit, possessing ordinary dexterity of manipulation and some rudimentary knowledge of the forms he is likely to encounter, may be promised a reward far more gratifying to himself and more useful to his fellow-workers than he can achieve by a lifetime devoted to the solution of the markings on a frustule of *Surirella gemma* or on the scales of *Lepidocyrtis curvicollis*. "Il n'est que le premier pas qui coute"—and here as elsewhere the chief obstacle experienced by the amateur worker, armed with his new high-power objective, and ardent to win his spurs as an original discoverer, is, beyond doubt, the selection of a subject. In recognition of this difficulty of making a commencement, and also of the assistance and encouragement that may often be derived from the narration of personal experience gained in the striking out of a novel field, a brief account will here be given of some of the results of a rather successful forage or series of forages conducted by the writer during leisure hours within the last few years, in association with certain newly discovered or previously little known Flagellate Protozoa; all these forms again, without exception, requiring for their satisfactory interpretation the employment of those powerful and high-class magnifying powers referred to in our opening sentence.

It will no doubt be remembered by many readers of this journal that certain members of the Flagellate Protozoa, embracing several of those free swimming monads which occur abundantly in fish and other animal macerations, have already been brought before their notice.* On this occasion, however, it is proposed to give a brief descriptive outline, with illustrations, of an extensive series of forms that have so far, on account of their exceedingly minute size, altogether evaded the notice of the microscopists of this country, but which at the same time most certainly surpass all previously discovered types equally in the wonderful symmetry of their individual form and in that of their aggregated mode of growth. So long ago as the year 1866 a few stray members of this Flagellate group, to which attention will now be directed, were made known to the American scientific world by Professor H. James Clark, of Pennsylvania, U. S. A., who described and figured four species only, three of these inhabiting fresh and the remaining one salt water. Most unfortunately for science this authority did not long survive his discovery of these new forms, and had, consequently, no opportunity of further extending and fully maturing his acquaintance with the same. Since the death of Professor Clark no other investigator, with the exception of the contributor of this article, appears to have knowingly encountered a single representative of the group in question, which may thus be said to have vanished from scientific cognizance.

The first acquaintance made by the writer with the new group of Flagellate Monads now to be introduced was in the autumn of the year 1871, when occupied in investigating the infusorial fauna of a small pond situated in the North London district, and fed by water from the New River Company. What at first sight during these researches presented the aspect of numerous closely aggregated colonies of a minute species of *Epistylis*, resembling the *E. botrytis* of Ehrenberg, proved upon more accurate examination, and with the aid of a magnification of about 700 diameters, to be identical with the new type introduced by Professor Clark a few years previously, under the title of *Codosiga pulcherrima*. A representation of this earliest discovered and very elegant compound pedicellate monad will be found at Plate 1, Fig. 9, accompanying this article. The identity and structural peculiarity of this type having been once recognized, a very brief investigation sufficed to detect in the water of this same pond the whole of the three fresh-water species originally found and described by Professor Clark, and, in addition, a fourth and still more remarkable and luxuriant-growing variety. A brief announcement of this discovery within British waters of these interesting Flagellate types, with notes upon a few other allied forms, was communicated to the November meeting of the Royal Microscopical Society of London, and appeared in the Society's Journal for January, 1872. From that period up to the present date continued researches by the writer in the same fertile field have been so far rewarded that the borders of this interesting, and as now shown widely distributed group, have had to be extended for the admission of some forty or fifty well-marked species. From a numerical point alone, indeed, it has now been demonstrated to occupy as important a position as any of the leading and natural divisions of the lower Protozoa recognized previous to this discovery; while in structural organization they exhibit so novel an aspect as to demand the creation of a new sectional title equivalent to that of an order, if not a class, for their reception.

A glance at the two plates illustrating this article (perhaps already taken) will at once place the reader *en rapport* with the essential characteristics and more important known varieties of this newly-discovered group, and which are here reproduced with considerable reduction in both size and number from the fuller details that accompany an extended monograph of the same now awaiting publication.* The most prominent feature of all these types, and one that serves to conspicuously distinguish them from all previously known Protozoic forms, is the presence at the anterior extremity of each individual monad of a hyaline, wineglass-shaped expansion, from the center of the base of which the long lash-like flagellum takes its origin. On this remarkable wineglass-shaped structure Professor Clark originally bestowed the appropriate title of the "collar," and by this appellation it will hereafter be distinguished. Specifically, this delicate hyaline organ, the collar, is of such extreme tenuity that its true form and nature can be brought out only by a very careful adjustment of the achromatic condenser or other accessory illuminating apparatus employed, and is even then exhibited to the greatest advantage by supplying the type under examination with artificial food, such as carmine or indigo. Under the condition last premised it will be found that this collar consists of a thin infundibuliform film of sarecod that may be protruded from and withdrawn at will into the general substance of the monad's body in the same manner as the sarcode prolongations or pseudopodia of an amœba or other Rhizopod. As in the pseudopodia of certain Rhizopods, such as the Foraminifera, it will likewise be found that notwithstanding the extreme tenuity of this sarcode film, a circulation of its substance is being constantly maintained, flowing upward on the outside, over the distal edge or rim, and downward on the inner surface, at the base of which it again comes in contact and merges with the general sarcode of the body. The services performed by this wineglass-like film of sarcode as a branchial or respiratory organ are doubtless considerable, but this by no means represents its most important function. In conjunction with the centrally inclosed vibratile flagellum it represents the most admirable trap or snare for the capture and retention of food that can possibly be imagined. Whirling round with inconceivable rapidity this last-named organ, the flagellum, creates a strong current in the water, setting from behind forward in the direction of its own apex, and bringing with it all such tiny organic particles as do not possess sufficient power to stem its tide. But for the outspread collar these atomic particles would simply hurry with the stream past the monad's body and out of reach. Not for them, however, such an easy passing of the rapids. The dangers of dread Scylla lurk midway in the whirlpool of Charybdis! In the midst of their swift career they strike against the outer surface of the almost impalpable film of sarcode of which the collar is composed, and to this they now adhere as tenaciously as the snared bird to the lime-covered twig, or an incautious fly to a spider's web. Then slowly, almost imperceptibly, the captive atoms, be they alive or dead, are carried along with the circulating current of the collar's substance, until, on reaching the base of the interior of this structure as just now described, they are there engulfed within the sarcode substance of the monad's body as within a living grave. A diagrammatic illustration of the *modus operandi* of this remarkable feeding process, and also the aspect presented by one of these monads that was induced to make a hearty meal off minute particles of carmine, will be found at Pl. 1, Fig. 19. The food-particles after ingestion, as above, are gradually accumulated into spherical agglomerations, and then passed within the interior of the body in a manner identical with that accompanying the feeding process of Vorticella or other of the higher Infusorial types. Refuse, or undigested residual particles of food, are finally liberated from the same area, limited by the base of the collar within which they primarily gained access. In common with apparently all other representatives of the Protozoa, these minute collar-bearing monads possess from one to two or more of these rhythmically expanding and contracting spaces distinguished by the title of "contractile vesicles." With these structures there is usually associated the function of a rudimentary heart or respiratory organ, and in this particular group they are most generally situated at the posterior extremity of the monad's body.

Passing now from such characters as are shared in common by all the members of the Flagellate group to those which serve to distinguish them individually from each other, one is amazed at the infinity of form and variation in the arrangement of similar primary elements that are presented. The essentially plant-like aspect of many of these constitutes one of their most conspicuous features, to which has also to be added the remarkable extent to which will be here found foreshadowed on a much more minute but surpassingly luxuriant scale those individual or aggregated types of growth hitherto supposed to be confined to the more highly organized Ciliate order of the Infusoria. Examined from this latter point of view, the various species of *Codosiga*, consisting of numerous individual monads grouped together on a simple or branching footstalk, immediately recall to mind the compound pedicellate colonies of *Epistylis* or *Zoothamnium*; few, however, among these latter presenting such an exuberance and symmetry of growth as is instanced by the forms *Codosiga cymosa*, *alloides* and *umbellata*, illustrated by Figs. 1, 4, and 5, on the first of the accompanying plates (Pl. 1.). The solitary species, belonging to the genus *Monosiga*, again, *ib.* Figs. 16 and 18, may be accepted as corresponding with the simple and initial factor of the group typified in the same higher Ciliate order by the genus *Vorticella*. This simile in association with the family of the Vorticellidæ may be carried yet further, for while among these latter there occur genera, *e.g.*, *Cothurnia* and *Vaginicola*, in which the animalcules secrete around them chitinous protective sheaths or loricæ, so likewise we find what may be regarded as a homologous structure repeated in the genus *Salpingœca* (Plate 2, Figs. 2, 9, 11, etc.); though in this instance with a diversity of contour altogether unapproached in either of those higher types. This genus *Salpingœca* is alone, in fact, worthy of independent study if only on account of the exquisite variety of form presented by these protective sheaths, many of which may be said to vie in chasteness and elegance of design with the classic vases and amphoræ of the ancient Greeks. In the genus *Lagenœca* (Plate 2, Fig. 42) is found a freely floating loricate type, which may be compared with the Ciliate genera *Tintinnus* or *Codonella*; while in *Polynœca* (Plate 2, Fig. 1) is encountered a variety whose compound lorica resembles the polypary of a minute Sertularian Zoophyte, and which has no parallel among that higher order of the Protozoa with which previous comparisons have been instituted.

Not less interesting than the varied forms of the protective loricæ of these collar-bearing monads, as above referred to, are the protean shapes assumed at will by their minute occupants during both their adult and developmental states. A variety of the more remarkable of these will be found represented in the accompanying illustrations. Thus one of the most cosmopolitan representatives of the tribe, *Salpingœca amphoridium*, while under ordinary conditions exhibiting that aspect characteristic of all other members of the group broadly described in a preceding column, is at times, to all but the initiated, metamorphosed beyond recognition. In one of these phases (Plate 2, Fig. 4) it will be seen that while the flagellum remains extended, a portion of the body-sarcode of the monad is protruded from the aperture of the lorica. A still more singular form frequently assumed by this same species is delineated at Fig. 5 of the same plate. Here both the collar and flagellum have entirely disappeared, and one-half or more of the body-substance is projected from the orifice of the lorica in the form of numerous lobate processes resembling the pseudopodia of a *Difflugia*, to which Rhizopodal type the creature now bears a close resemblance. By patiently watching an example presenting this Difflugian aspect it was found that in a little while the protruded lobate portion became gradually separated from the posterior half, and floated away in the form of a minute stellate amœba; this subsequently attaching itself, developed a new lorica, and grew into a collar-bearing form, identical with that from which it originally sprang. The posterior half, left in the parent domicile, speedily acquiring a new collar and flagellum, is not to be distinguished from the normal aspect it presented previous to entering upon the process of transverse fission. Another and characteristic phase frequently observed in association with this same species is that quiescent, or "encysted," condition represented at Plate 2, Fig. 7. During this period of its life-history all external signs of vitality are suspended, and the body of the monad shrinks into a spherical or ovoid shape within its flask-like habitation. A little later this encysted monad breaks up into numerous locomotive spore-shaped bodies, each furnished with a single flagelliform appendage. These, after dispersing themselves through the surrounding water, become attached, and growing to the likeness of the parent form lay severally the foundation of future colonies. An illustration of the liberation and dispersal of the locomotive spores or germs of an allied species, *S. fusiformis*, is given at Plate 2, Fig. 26.

While the mode of increase by fissi-gemmation in the loricate type *Salpingœca* almost invariably takes, as already described, a transverse direction, it appears in the compound pedicellate genus *Codosiga* to as constantly follow a longitudinal one, it being, indeed, this latter mode of fission, accompanied by the adherence to one another of the individual monads by their bases, or to the common supporting stem, that the luxuriant colony-forms of this beautiful genus are produced. A single monad of *Codosiga pulcherrima* is shown at Plate 1, Fig. 10, in the act of dividing into two by this last-named characteristic mode of fission, and in which process it will be seen that the division extends to both the hyaline collar and the flagellum. These several processes of multiplication—by fission in a twofold manner and by the breaking up of the parent body, after encystment, into locomotive spores—are found to persist not only throughout this special collar-bearing group, but must now evidently be accepted as presenting the normal method of reproduction among all Protozoic structures. Preceding this more important mode of increase by the resolution of the parent body into spores, it frequently happens that two or more individuals coalesce or fuse intimately, mostly in an amœboid form, with one another, and produce one single capsular encystment. This process, however, does not appear in all cases to be essential. Taken as a whole, the representatives of the protozoic or unicellular animal sub-kingdom are thus shown to agree in their reproductive and developmental phenomena with the unicellular and other lower cryptogamic plants, and might therefore with equal justice be appropriately denominated cryptogamic animals. These two animal and vegetable groups again exhibit a further striking parallelism, inasmuch as neither in the former does a true egg, nor in the latter a true seed, constitute the essential reproductive product, as is the case with all of the more highly organized structures on either side. Among the developmental phenomena, supplementary to the foregoing, presented by the collar-bearing group here specially considered, that associated with the building up of the protective sheath of the loricated genus *Salpingœca* is well worthy of notice. This structure, as shown in the case of *S. ampulla* at Plate 2, Figs. 13 and 14, takes its origin as a mere mucus-like excretion from the surface of the monad's body, and at a period prior even to the appearance of the collar. In a very short time after its excretion the lorica acquires its normal consistency, and is then of considerable solidity, as is proved by its retention of its form for a considerable interval after the death of its original occupant.

Absorbing as the investigation of these minute independent collar-bearing monads is sure to become to any microscopist adopting the same as a subject for study, on the merit of their intrinsic beauty and variety of form alone, it has yet to be shown that they possess a still more interesting and important bearing with reference to their relationship or affinity with certain other animal

* See Article on "Recent Researches in Minute Life," by H. J. Slack, F.G.S., Pop. Sci. Rev., vol. xiv., p. 245. 1875.

* These fuller details are embodied in "A Monograph of the Collar-bearing Flagellata, etc., etc.," communicated to the meeting of the Linnean Society held June 21, 1877.

organisms. Prof. H. James Clark, the authority already quoted as the first to report the occurrence within American waters of some three or four varieties of these collar-bearing species, simultaneously announced his discovery that one of the calcareous-spiculed sponges (*Leucosolenia botryoides*, Bwbk.) consisted of aggregations of essentially similar collar-bearing monads, immersed within the structureless sarcode or spicule-producing element. This important discovery, confirmed by an examination of other species, Prof. Clark regarded as completely setting at rest the long-vexed question concerning the true nature and affinity of the sponges, and conclusively demonstrating the necessity of their recognition as colony-building flagellate infusorial forms. Prof. Clark's decease shortly after this announcement, together with the novel theory concerning these same organisms that was brought forward at about the same date by Prof. Ernst Hæckel, and in which it was sought to show that the sponges were referable to a far more highly organized animal group, served to almost entirely divert the attention of biologists from those views that originated with the first-named authority. Notwithstanding, however, this temporary diversion of scientific thought into a novel, and, at first sight, sufficiently plausible channel, the researches of recent investigators are tending to confirm the views of the American naturalist, almost all of these being unanimous in recognizing that the ciliated lining of the various-shaped sponge-cavities is essentially composed of collar-bearing flagellate cells similar to those just described as existing in *Leucosolenia botryoides*. Although thus admitted, however, by such authorities to constitute an important element in all sponge-structures, very few are at present inclined to concede to these collar-bearing flagellate cells the primary position assigned to them by Prof. Clark. In accordance with the view of the former, indeed, each such flagellate collar-bearing cell is not to be regarded as a separate and independent monad or individual, but merely as a single cell-constituent of a continuous and epithelium-like internal lining membrane.

The above-mentioned opposing views held respecting the true nature and affinity of the sponges may thus at the present day be said to provide material for as fierce a controversy between leading scientific authorities as was maintained in similar circles during the first half of this century relative to the claims of these same organisms for admission into the ranks of the animal kingdom, and which has not for so very long a while been universally accorded them. If, as Prof. Hæckel and the advocates in whole or in part of his theory assert, sponges are composed of separate multicellular membranes or tissues, they undoubtedly find their nearest allies among the Cœlenterata, including the sea-anemones and hydroid zoophytes. If, on the other hand, as represented, by Prof. Clark, they consist of aggregations of unicellular collar-bearing flagellate monads, their place is unquestionably adjacent to the more simple unicellular Protozoa, including the ordinary monads, Rhizopoda, and Infusoria. The fuller light so much needed to determine once and for all this abstruse but exceedingly interesting question of the true nature and affinity of the sponges has without doubt been considerably obscured through the absence, since the death of Prof. Clark, of all further testimony or corroborative evidence relative to those independent collar-bearing monad forms upon which his arguments were essentially based, and which, if his views were correct, might be expected on a closer and more extended acquaintanceship to yield parallel structural and developmental data of the greatest importance. This hiatus in the chain of evidence was early recognized by the writer, and may be said to have directly led to the investigations pursued in reference to this group within the past five or six years, resulting in the discovery of the innumerable previously unknown species, many of which are figured for the first time in these pages. Having this amount of material available for correlation and comparison, the case for the advocates of the protozoic nature of all sponges has been immeasurably strengthened, while little if any substantial foothold would seem to be now left for the adherents of the opposite or cœlenterate persuasion. Examining numbers of sponges and comparing the structure and manifestations of their collar-bearing unicellular constituents with those of the solitary or colony-forming individuals of the genera *Codosiga*, *Salpingœca*, and others previously referred to, the phenomena elicited were found to be altogether identical. Every separate collar-bearing cell in these sponge-structures was found in a similar manner to possess a separate and independent existence, capturing its food in the same manner with its exquisitely hyaline wineglass-shaped trap of circulating sarcode, possessing the same posteriorly situated and rhythmically opening and closing contractile vesicles, dividing by longitudinal or transverse fission, and ultimately encysting and breaking up into countless germs or spores destined to grow to individuals identical with the parent form, and further extend the borders of the commonwealth. In common with the independent collar-bearing types, these sponge-monads were found also to be possessed of an equal or even greater amount of plasticity of external form, retracting their characteristic collar and flagellum, and assuming an amœboid aspect in a manner closely identical with what has been already described of *Salpingœca amphoridium* and *fusiformis*. Often, again, these sponge-monads (see Plate 1, Fig. 31), having the collar and flagellum withdrawn, throw out long, slender, capitate processes, which communicate to them an appearance closely resembling that of certain of the suctorial animalcules or *Acinetæ*.

That sponges, taken as a whole, possess a something over and above what is encountered in the simple, independent, collar-bearing monad types cannot for a moment be denied. What the distinction is, and the extent to which it complicates or masks their true nature and affinities, may be briefly explained. A sponge-body, cut through and examined with the microscope, though presenting at first sight an exceedingly complex type of structure, will be found on closer inspection to consist of a few very simple elements. Occupying, in the majority of species, the largest but by no means most essential portion of its composition, is the glairy, gelatinous sarcode, or syncytium, which forms, as it were, the basis or superstructure in and upon which all the other elements are distributed. Within its substance are imbedded, or, in fact, originated, when present, the various skeletal components, whether spicules, horny fiber, or a combination of the two, that give to the complete sponge that amount of rigidity or variety of contour that distinguishes the various species. Abundantly scattered throughout the substance of this slimy matrix will likewise be found the amœbiform bodies of every shape and size to which the name of "cytoblasts" has been latterly applied. Last and most essential of all are the collar-bearing flagellate monads or spongozoa, identical in form and structure with the independent collar-bearing species already introduced. These constituent sponge monads most usually either line the entire surface of the inner cavities of the sponge or occupy special spherical chambers within the same. These three living elements or factors now enumerated, namely, the glairy and structureless syncytium, the amœbiform cytoblasts, and the collar-bearing, flagellate monads, once intelligently recognized, the reduction of the sponge-structure to a still more simple formula is, with the light now afforded by a knowledge of the structure and developmental history of the independent collar-bearing types, a comparatively easy task. With such accessory light it may be shown, indeed, that the collar-bearing monads are the *only* essential factors, and that toward them all the remaining structures occupy an entirely subordinate position. Given, in fact, a single one of these constituent monads, and a perfect sponge-body can in a little while be progressively built up. By a mucus-like exudation from its surface the basis of the syncytium is laid in a manner absolutely identical with the process by which the at first mucilaginous but afterward indurated lorica or protective sheath of the genus *Salpingœca* is originated.* By a repeated process of cleavage or fissigemmation the original sponge-monad quickly multiplies itself, though still more rapidly and effectively by the subsequent encystment and breaking-up of the monad bodies into spores. In the independent collar-bearing types, as already shown, the germs or spores resulting from this process of encystment are discharged into the surrounding water, and thus dispersed to considerable distances. In the sponges, however, this act of encystment takes place within the substance of the syncytium, and within its substance are the spores released. In this element, moreover, they immediately find a most appropriate nidus or matrix for their future development, and are to be encountered on examination in every phase of transition. As it has been previously shown that the larval or initial conditions of the independent collar-bearing monads take the form of either amœbæ or simple flagellate monads, so also it will be found that the collar-bearing sponge-monads commence existence as similar simple units. Aided, indeed, by the light afforded by the developmental phenomena of this independent group it is easy to recognize that the amœbiform bodies of every variable shape and size dispersed among the syncytial element of the sponges are merely the larval or transitional conditions of the adult collar-bearing monads which they ultimately resemble. Between the amœbiform and the adult state there is usually also an intermediate stage, in which the sponge-monad, not having yet acquired the characteristic collar, possesses a single lash-like flagellum. An illustration of such intermediate flagellate types, taken from an example of a siliceous-spiculed sponge, *Halichondria panicea*, will be found represented at Plate 1, Fig. 32.

In addition to developing by fission, or as simple units or individuals, from the amœboid to the collar-bearing stage, and thus contributing to the further extension of the parent colony, it remains to be mentioned that in many, if not all, sponges there is another process of development attended with more complex phenomena, contributing to the production of detached and free-swimming monad-aggregations specially adapted to secure the wider distribution of the species. In this instance the amœbiform units, either as mature cytoblasts or as collar-bearing monads returned to an amœboid state, fuse or coalesce intimately with one another in variable numbers, producing by such an amalgamation an amœbiform body of considerable size. By a process of geometrical cleavage or multiple fission, this enlarged amœboid body now gives origin to a structure so closely resembling the "morula" that results from the primary segmentation of the ovum of all higher animals, that the nature of a true egg or ovum has been inaccurately attached to it by some authorities. By degrees each constituent segment of this moruloid body assumes a lengthened conical form, and, acquiring a terminal flagellum, presents in the aggregate the aspect given at Plate 1, Fig. 27.

Developing still further, this moruloid body finally, and in its most characteristic phase, exhibits the form shown at Fig. 28 of the same plate, and in which condition it may be described as a spherical or ovoid aggregation, hollow within, of typical collar-bearing monads or spongozoa, individually identical with those of *Codosiga pulcherrima* or any of the independent collar-bearing types figured on the same plate. Floating away in this condition the collars and flagella of the sponge-monads are subsequently retracted, a syncytial exudation is thrown out as a vail around them, the spicules or other skeletal elements make their appearance in the same, and the body, attaching itself by some point of its periphery, usually the posterior one, speedily presents in miniature all the essential features of the parent sponge which gave it birth. The special collar-bearing cells now project into the interior cavity, opening externally by a single flue or osculum, and rapidly multiply by those various processes of fission or resolution into spores already described.

By those hitherto insisting on the recognition of spongesa as animals qualified to rank with the Cœlenterata or lowest Metazoa rather than with simple unicellular Protozoa, the free-swimming compound gemmules just discussed have been seized upon as yielding the most conclusive evidence. The various arguments, however, brought forward in association with these structures in support of this cœlenterate view, have been considerably weakened since the first attempt made by Prof. Hæckel to establish for them a form and structure identical with his typical but hypothetical "Gastræa," or larval stockform of all animals higher than the Protozoa. This "Gastræa," consisting of a capsular body with a single terminal orifice and body-wall composed of two separate cellular membranes, an ectoderm and endoderm, was supposed to find its ideal personification in the compound ciliated sponge-gemmule. A more intimate and accurate acquaintance with these bodies has, however, revealed to numerous observers the entire untenability of this hypothesis. It is now definitely determined that there is no separation of the walls of the gemmule into an outer and inner cellular membrane or ectoderm, as originally premised, and no terminal orifice leading into the central cavity. The strongest and apparently the only argument, indeed, that can now be brought forward in favor of the affinity of the sponges with the Cœlenterata or other Metazoa, is the circumstance that these free-swimming gemmules are produced, as already notified, by a process of cleavage or segmentation resembling that usually regarded as the special property only of the true ovum of all higher animals, from the Cœlenterata upward. Could no instance be adduced in which parallel phenomena occur among other undoubted Protozoa, this argument would carry with it considerable weight. It has, however, been recently shown by the valuable researches of Messrs. Dallinger and Drysdale that, among certain simple free-swimming monad forms, the coalescence of two or more individuals may give rise to a precisely similar process of cleavage or segmentation, terminating in a similar moruloid structure. The component segments of this pseudo-morula, however, are the equivalents, as in the case of the sponge-gemmule, of distinct individual zooids, and which in this instance become finally separated from one another and distributed through the surrounding water as uniflagellate monads. It requires merely the permanent attachment in a colony-form of the individual units of Messrs. Dallinger and Drysdale's multiple-fission monad to produce a structure in all ways corresponding with the ciliated sponge-gemmule in its earliest stage, as shown at Plate 1, Fig. 27, and the addition to the same units in such an attached form of terminal hyaline collars to typify the still more characteristic phase illustrated at Fig. 28.

The close relationship which undoubtedly subsists between the sponges and the, as now shown, extensive group of independent collar-bearing Flagellate Protozoa represented in luxuriant variety in the accompanying plates, will scarcely be called in question by those who, first making themselves acquainted with the members of this last-named group, turn their attention to the physiology of the sponges. It is only, indeed, through such a preliminary acquaintance with the more simple independent forms that this intricate question of the nature and affinities of these more complicated aggregations of otherwise essentially similar units can be satisfactorily approached. While, therefore, recommending the newly-discovered group of independent collar-bearing Flagellate Protozoa to the attention of working microscopists, it is much to be desired that they shall supplement such observations as they may make in connection with the same by a practical examination of the structure of all such sponge forms in the living state to which they may have access. In either field our knowledge may be said as yet to extend no further than the threshold, and in each of the same there is probably more original discovery waiting to be achieved than in any other group of the organic world. The forty or more specific types of the independent collar-bearing forms that have rewarded the writer's desultory investigations, spread over some five or six brief years, may be safely accepted as representing but a very small installment of the innumerable varieties that are doubtless awaiting a more thorough and systematic research; while of the sponges it may be said that we are as yet but imperfectly acquainted with the complete structural and developmental phenomena of even half a dozen out of the many hundred discovered species. In reference to these last-named organisms it is worthy of remark, before taking leave of them, that Professor H. James Clark, when first pointing out the intimate relationship between their essential living units and the two or three independent collar-bearing forms discovered by himself, hazarded the opinion that future investigation would probably reveal that different groups of sponges were composed of monads, corresponding in individual structure or presenting combinations of the various independent generic types; and this anticipation has been remarkably fulfilled in the case of one of the simplest known sponge forms recently discovered, and to which the name of *Gastrophysema primordialis* has been given by Professor Hæckel. A small fragment of this interesting variety with its characteristic internal lining of collar-bearing monads is shown at Plate 1, Fig. 38, and this type may be said to present an amalgamation of the generic characters of the two genera, *Codosiga* and *Salpingœca*, certain of the monads being naked as in the former genus, and others inclosed within a flask-shaped lorica, as in the latter one. In the last-named instance the monad illustrated has entered into a quiescent or encysted condition within its lorica, presenting under such circumstances an aspect absolutely identical with the similar encysted condition of *Salpingœca amphoridium* shown at Plate 2, Fig. 7. Professor Hæckel, unaided by an acquaintance with the independent collar-bearing forms here described and illustrated, and assuming for all sponges a cœlenterate type of organization, has singularly associated with these flask-shaped loricæ and their encysted contents the structure and functions of rudimentary glandular organs.

Before leaving the microscopist to make his first essay in that new and fertile field for investigation to which his attention is now directed, a few hints as to the conditions under which the most complete success is likely to be achieved may prove acceptable. The first matter of importance is his apparatus; and here, should he not be in a position to command one of the highly-perfected achromatic object-glasses of our best English makers, let him be by no means discomfited. A German one-sixteenth inch immersion lens, yielding a magnifying power of from 700 to 2,000 diameters and upward, may be obtained at Mr. Charles Baker's, of 244 High Holborn, for the modest sum of £3. Such an object-glass will be found equal to interpreting the form and structure of any of the numerous types figured in the accompanying plates, and with such a lens, indeed, the whole of these forms were, with but few exceptions, in the first place discovered and delineated by the writer.

The mechanical apparatus being decided on and obtained, it remains only to select the material for investigation. Either salt or fresh water will be found to yield its quota of the types required, and those frequenting the last-named element, being usually the more accessible, will most probably command first notice. Here the investigator will find his time most profitably employed in procuring from the nearest weedy pond or ditch a bottleful of the finely-divided leaves of Myriophyllum, or of tangled confervoid growths, in either case selecting more especially those brown-hued specimens colored by a dense incrustation of other more minute vegetable and animal parasitic growths. Care should likewise be taken to inclose with the water as large a number as possible of the specimens of *Cyclops* and other Entomostraca abundant in such situations, and to which will be frequently found attached species rarely, if ever, to be met with elsewhere. Patiently exploring every filamentous division of the above-mentioned weeds with the lower of the two powers employed, it will be scarcely possible to miss encountering one or more of the species illustrated in the accompanying plates. As first seen with this lower or reconnoitering power, it will, of course, be almost impossible to distinguish the characteristic collar, and the monads will appear as mere luminous specks adherent to the plants under examination. Meeting with these, the higher power must be brought into focus, when the true nature of the organisms will be revealed. Among the varieties which are likely at first to be encountered are, perhaps, the two loricated species *Salpingœca amphoridium* and *fusiformis* (see Plate 2, Figs. 3 and 23), the former often completely incrusting several consecutive joints of various thread-like confervæ, while the latter will occur as solitary individuals scattered about at uncertain intervals.

* Several higher ciliate infusorial forms produce a mucilaginous investing sheath by a similar process of exudation. In one of the most conspicuous of these, *Ophrydium versatile*, large colony-masses are formed containing hundreds of separate individuals all inclosed within a common gelatinous investing sheath, and presenting a general aspect clearly resembling that of the fresh-water sponge, *Spongilla fluviatilis*, with which it is frequently associated.

On the stronger fulcrum for support afforded by the leaf-partitions of Myriophyllum, the illoricate species *Codosiga pulcherrima* (Plate 1, Fig. 9) is often present in great profusion, its sociable pedicellate colonies being so thickly placed as to present the appearance of a perfect little forest of crystal-fruited trees. More rarely, under similar conditions, the extremely elegant and symmetrically tripartite branching pedicellate form *Codosiga umbellata* (Plate 1, Fig. 4) may be likewise met with.

At the outset, considerable difficulty will doubtless be experienced in the satisfactory definition of the hyaline collar characteristic of all the members of this group, a most careful manipulation of the light being often requisite to show this structure to advantage. It frequently happens again that when the entire contour of the wineglass-shaped collar is not to be distinguished, its presence is indicated by the clearer outline of its two lateral margins, which, standing out at an acute angle from the perpendicular line formed by the central flagellum, present the aspect of two additional hair-like processes. The appearance of this organ, when seen as described in the last sentence, is indicated at Plate 2, Fig. 41, illustrative of the so-called "animalcule with ear-like processes," figured many years since by Mr. Carter, but which undoubtedly represents a species of *Salpingœca* with the characteristic collar indistinctly seen. In a similar manner other species now shown to belong to this newly discovered collar-bearing group have from time to time been imperfectly figured by various authorities, who, when encountering them, have not employed sufficient magnifying power or that mode of illumination requisite for the interpretation of their true character.

Having, with the assistance of these few hints, made himself familiar with but two or three only of the interesting types here introduced to his notice, the investigator will experience but little difficulty in extending the circle of his acquaintanceship with the same, and can scarcely fail before long to become so absorbed in admiration of the infinite variety of form and vital phenomena they present, as to regard as lost any further time bestowed on the markings of either Diatoms or Podura scales—*et hoc genus omne.*

THE SYNTHESIS OF THE LICHENS.

THE greenish or yellowish membranes which are found attached to trunks of trees, the gray spots which cover rocks, the curious vegetable substance which adheres to the boughs of oaks and firs, or sometimes appears on the ground like the mosses, constitute the large family of cryptogams known as Lichens. The study of these growths offers many difficulties, and it is comparatively recently that their organization and strange mode of life have been revealed. Their manner of fructification prevents their being separated from the fungi, and yet the large number of green chlorophyll cellules which they contain places an obstacle in the way of this classification, for fungi are never green.

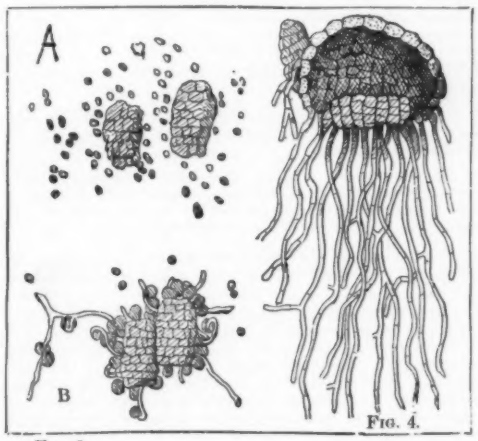


FIG. 3.

The organization of the lichen may be seen by examining microscopically two species, the *Collema* and *Endocarpon*, a thin section being cut through the tissues of each perpendicularly to their flattened surface. These sections are represented in Figs. 1, C, and 2, A. In both of these lichens there is seen in the middle portion whitish filaments which interlace, forming a closer network as the edges are neared. In the midst of these filaments, which resemble those of the mushroom, can be seen scattered cellules round in shape and green in color. In the *Endocarpon*, Fig. 2, A, these cellules are isolated, while in the *Collema*, Fig. 1, C, they form small garlands which wind in and out of the meshes of the filaments. To these cellules the name *gonidia* has been given, and through the action of their chlorophyll they fix the carbon of the carbonic acid of the air, under the influence of light, and so enable the vegetable to live independently and not as a parasite after the manner of the fungi. As the structure of the filamentous network may be very different in different species of lichens, so also may the forms of the gonidia vary. They may be simple small unicellular grains as in the *Endocarpon*, sometimes cubical, oval, or in parallelopiped form, or they may be cylindrical or arranged in chaplets, as already noted.

The fructification of the lichen as shown in the Endocarpon section resembles that of some of the fungus family, notably the moielles and truffles. Here and there are found salient portions (Fig. 1, A) brilliantly colored in yellow or red. In other parts these become simply dark spots indicating the place where the reproductive apparatus exists. Generally there is a cavity hollowed in the mass of the lichen (Fig. 2, A) containing in the midst of its cylindrical filaments a certain number of long cellules larger at the summit than at the base—within these elongated pear-shaped parts the spores are formed. If the successive development of the fructifying material be studied, the contents of the special cellules will be seen to separate into a certain number of small masses which detach themselves from the sides and eventually are set at liberty by the destruction of a part of the membrane which contains them.

Here, however, a curious anomaly is encountered. If the naked spores be placed on the bark upon which the parent lichen normally grows, no matter what the conditions of heat and humidity may be they will not reproduce a new lichen—and in this respect they differ altogether from the mushroom spores which under analogous conditions will germinate. Now, by studying comparatively the green gonidia of a large number of lichens and the inferior unicellular or filamentous algæ which grow on rocks and trees, M. Schwendener has discovered that each gonidia of the lichens corresponds to an absolutely identical free alga. The algæ it will be remembered are a large family of cryptogams, including the sea weeds and a number of species which grow on rocks and trees, deriving their moisture from the air. Thus, for example, M. Schwendener has shown that the nostocs (Fig. 1, B), which are small fresh water algæ which form blackish green masses at the bases of trees,

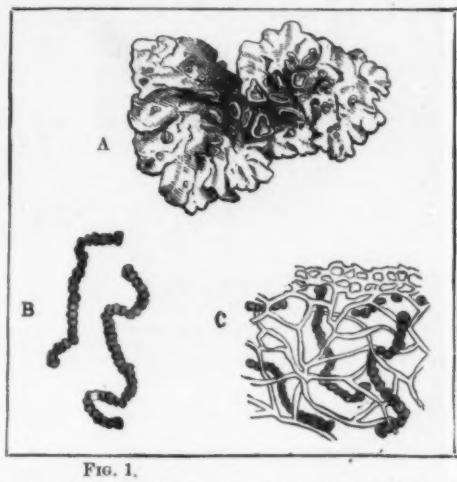


FIG. 1.

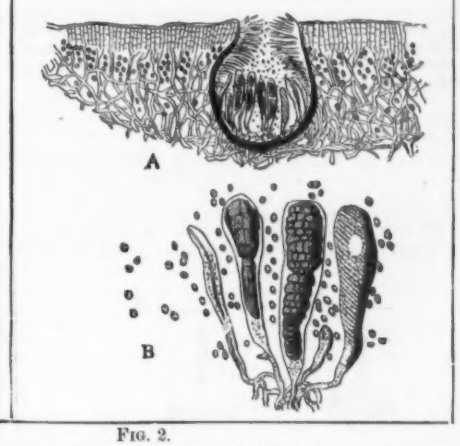


FIG. 2.

rocks, and walls, are in all respects similar to the gonidia of the *Collema*, Fig. 1, C. Another alga much more common, which covers with green the moist trunks of all trees, has the same form as the gonidia of the *Endocarpon*.

From his investigations M. Schwendener has determined a theory of the constitution of the lichen, which he considers not to be a vegetable species but the association of two different species—the algæ and the fungi. Lichen gonidia, he says, are algæ, and the fungus is a parasite of the latter, which it surrounds with its filaments. It takes from the algæ carbon which it assimilates for the entire colony, by means of the green chlorophyll which it contains. The *Collema* (Fig. 1, C) would thus be the association of an ascomyces fungus and the alga *Nostoc;* the *Endocarpon* that of another fungus and the alga *Cystococcus*. The alga can live alone; the fungus cannot. Without the alga the spores of the latter become abortive, whence it would seem that the fungus is a parasite of the alga, although in reality if this is true the inverse also exists, as we shall presently see. If the alga is useful to the fungus, so is the fungus to the alga. It may assimilate nitrogen directly, for example, and furnish it to the alga, while the latter returns in exchange the starch which it abundantly forms. There therefore exists between the two associates an amicable interchange of nitrogenous and hydrocarbon matters.

In order to verify M. Schwendener's theory, the result of analysis, synthesis is the best means. That is to say it is necessary to determine whether with a fungus spore and an alga a lichen can be produced showing all the characteristics of those of natural growth. Experiments in this direction have been made by Messrs. Rees, in Germany, and Bornet, in France. Rees has formed a gelatinous mass analogous to a true *Collema* by causing the spores of the *Collema glaucescens* to germinate on the *Nostoc lichenoides*, but he obtained no fructifications, and hence his synthesis was not complete.

Bornet has made a number of incomplete recompositions, and among them one very interesting experiment. The *Endocarpon miniatum* has gonidia which resembles the alga *Cystococcus*. In order to determine whether the identity exists M. Bornet has extracted these gonidia from the tissue of the lichen and has succeeded in keeping them living and self-multiplying for more than a year. To all these experiments, however, the objection may be urged that the artificial lichens have never fructified and that the cycle has never been completed from spore to spore. More recent investigations have however removed this difficulty, and the hypothesis of Schwendener has been reduced to practical certainty by the late work of M. E. Stahl.

An account of his labors has recently been published in Leipsic, and an abstract of them appears in *La Nature*, to which journal we are indebted for the illustrations given herewith.

Returning to the section of the lichen Endocarpon represented in Fig. 2, A, it will be observed that in the cavity in which the spore bearers exist there are numerous little points surrounding the latter. These are gonidia of the same form as those of the vegetable tissue, but smaller. Not being in contact with the fungus filaments they do not exchange nourishment with them, and hence are less developed. They accumulate however around the spore cellules as the latter become ripe, and as fast as the spores leave the membranes which envelope them, these little gonidia accompany them. A mixture is thus formed of fungus spores and partially developed gonidia which escape at the maturity of the fructification of the lichen, Fig. 3, A. Placed in exterior favorable conditions this mixture goes on to develop. The small unicellular algæ attach themselves to the spores and take nourishment while giving back support through the action of their green parts under the influence of light, Fig. 3, B. Each spore emits on all sides cylindrical filaments which develop themselves around it, and these elongate more and more, unite, and envelop the small algæ which they meet until a definite association is established.

It is not at all necessary that the small algæ should come from the same lichen as the spores. M. Stahl has succeeded in producing the same development with other gonidia and other algæ.

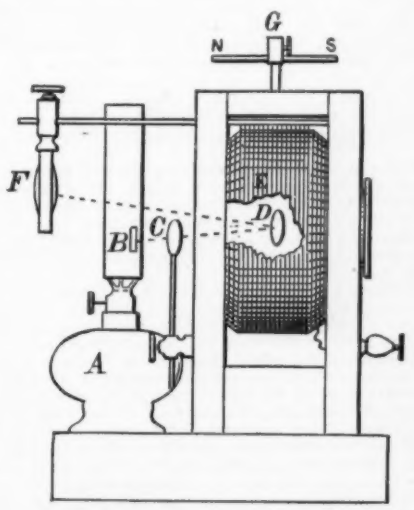
Meanwhile the white fungus tubes continue to increase more and more, while the algæ multiply and each separates into three or four others. Then a sort of regularization takes place in the entire colony, all the algæ uniting themselves into a false median tissue. On one side this green mass is covered with a colorless membrane; on the other all the elongated filaments of the fungus take the largest proportions, Fig. 4. Here culture on glass is arrested, but if the initial sowing is done on moist earth development continues, and M. Stahl has reconstituted the Endocarpon analogous to that in Fig. 2, completing the entire cycle of transformations and thus definitely establishing the constitution of the lichens.

These curious organisms, therefore, offer one of the rare natural examples of a community of two absolutely different species maintained to the benefit of both. Nor does the utility of the association stop with the interchange of nourishment. The alga, when set at liberty, requires great atmospheric humidity. A single ray of sunlight falling on the green covered trunk of a tree of the small Pamella algæ is often sufficient to dry them up and kill them; while if these same Pamella are associated with a fungus, to make a lichen of which they constitute the gonidia, the coherent mass of tissue retains its humidity for a long time, and thus sustained and protected the alga is able to keep its vitality despite surrounding dryness. With regard to the fungus, we have seen that the alga not only furnishes it with carbon, but it is often indispensable to the germination and always to the fructification of the former.

CONVENIENT ARRANGEMENT OF THE MIRROR GALVANOMETER.

By A. FLOYD DELAFIELD.

THE mirror galvanometer is universally recognized as the most delicate instrument of the kind. It is used for electrical measurement, and also on account of its showing the presence and direction of very feeble currents as a receiving instrument on the Atlantic cable. In its ordinary form it consists of a coil of fine insulated copper wire wound round a brass or copper tube, in which a thin mirror is suspended by a fiber of silk. To the back of this mirror are fastened two or three little magnets. A convex lens can be moved back and forth in the tube. In order to use this form of galvanometer it is necessary to have a screen of peculiar construction. It is a board about two feet long and ten inches high, which is placed in front of the instrument at a distance of two or three feet, standing at right angles to the axis of the coil. A scale of equal parts is fastened to the board, and below the center of the scale is a slit behind which stands a lamp. The light from the slit is reflected from the mirror, and an image of the slit is formed on the scale. For many purposes, and especially for lectures, the screen with a lamp behind it is inconvenient. The object of the arrangement here described is to dispense with this screen and use a blackboard or other surface usually found in lecture rooms. For this purpose the lamp is placed on the base of the instrument. An ordinary little kerosene night-lamp, A, is taken, and the chimney removed and replaced by a brass tube two or three inches long, in which is cut a small slit, B. A mirror, C, is placed so as to reflect the light from this slit upon the magnet mirror, D, within the coil, E. This mirror is of microscope glass, silvered on the back, and to the back of it are fastened with shellac four pieces of No. 11 sewing needle, which are all magnetized in the same direction. A convex lens, F, of 6" or 7" focus, can be moved along a rod projecting from the frame of the instrument. At the top of the frame a small magnet, G, is placed, which is used to bring the suspended mirror at right angles to the axis of the coil. The instrument is placed on a lecture table facing the blackboard, which should be chalked or covered with white paper where the image is to fall. On darkening the room and adjusting properly the lens and directing magnet, a magnified image of the slit will be seen on the board. An instrument of this pattern with a coil of one pound of No. 28 wire was placed seven feet from a blackboard. The



NEW MIRROR GALVANOMETER.

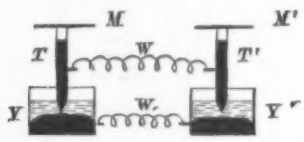
battery used was a copper cup the size of a percussion cap, containing a drop or two of diluted sulphuric acid into which dipped a little zinc spiral. With this battery and an interpolated resistance of 9,000 ohms, a resistance one-eighth greater than that of the Atlantic Cable, a large deflection was obtained.

THE TELEPHONE.

A MODIFICATION of the telephone is described in the *Moniteur Industriel Belge*. The receiving instrument is in all respects identical with that known as Professor Bell's. The transmitting instrument is thus constructed: The bobbin of wire in the ordinary instrument is dispensed with, and the magnetized core replaced by a bar or screw of copper. This is brought as closely as possible to the vibrating iron disk. The copper is connected with one pole of a battery, the other pole being to earth. The vibrating disk is connected with the line wire, which is attached at the other end to the receiving instrument, the circuit of course being completed through the earth.

BREGUET'S TELEPHONE.

M. BREGUET has invented an entirely novel telephone, based on the principle of Lippmann's electro-capillary electrometer. The transmitter and receiver are exactly alike, and each consists simply of a glass vessel containing a layer of mercury over which floats a layer of acidulated water. Into this water dip the point of a glass tube containing mer-



cury. The upper part of the glass tube contains air, and may be open to the atmosphere or closed by a plate or diaphragm capable of vibrating. The circuit is formed by connecting up the mercury in the tube of the transmitting telephone with that in the receiver, and also the mercury in the vessel of the transmitter with that in the receiver. When one speaks over the top of the tube of the transmitter the vibrations of the air are transmitted through the mercury to the point of the tube where the mercury makes contact with the acidulated water of the vessel by the fine capillary bore of the tube. Here the electro-capillary action takes place, the vibratory motions of the mercury generating electro-capillary currents which traverse the circuit to the receiver, and by a reverse process reproduce the air vibrations at the top of the tube of the receiver. M. Breguet says that this telephone, unlike Professor Bell's, is capable of reproducing not only oscillatory motions of the air, but of reproducing the exact range of the most general movements of the vibratory plate. A portable form of this instrument, constructed by M. Lippmann, consists of a fine glass tube several centimeters long, containing alternate drops of mercury and acidulated water, so as to form an electro-capillary series. It is sealed at the ends, by which two platinum wires make contact with the terminal mercury drops. A *rondelle* of firwood is fixed normally to the tube by its center, and gives a larger surface for the voice to act against, so as to furnish more motion to the tube when it acts as a transmitter, and be easily applied to the ear when it is a receiver.

M. Breguet claims for this telephone that it will act through submarine cables with instantaneous effect, because it will only establish *variations of potential* at the sending end of the line, and, unlike other telephones, will not generate *currents* to flow through the line. But this claim does not appear to us to be justifiable, since currents must result in the line from the variations of potential set up, and if there is to be any communication at all, they must travel throughout the length of the cable from end to end.

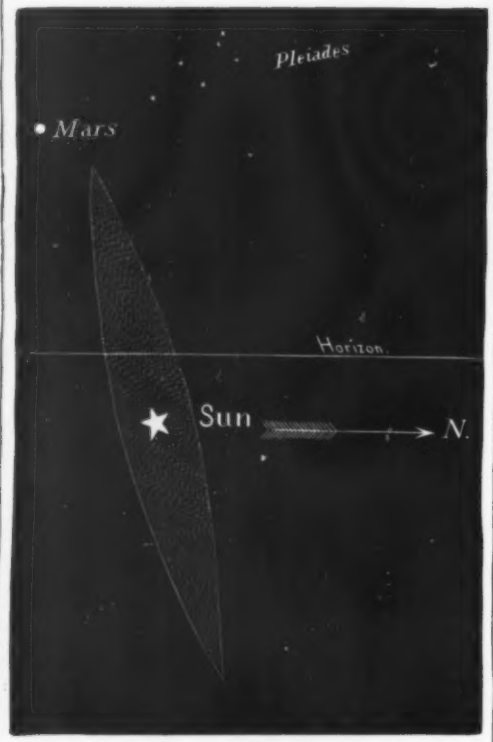
THE ZODIACAL LIGHT.

By PROF. C. W. PRITCHETT.

SOME of our recent clear nights have afforded fine opportunities to see this phenomenon at its best. It is, however, really surprising that *so few persons* ever see it during their whole lifetime. As I write for students and general readers rather than for astronomers, this note is made in the hope of inciting attention to something very *easily seen* and still very *curious*.

The Zodiacal Light, first so called by J. D. Cassini, in 1683, is apparently a faint luminous cone, whose axis extends from the sun, along the plane of the sun's equator, to a distance of from 30° to 105° from the center of the sun. The variable length of the axis is *apparent*, not *real*, and is due to the varying inclination of the sun's equator to our horizon at different seasons of the year. The light is brightest and is recognized as extending further from the sun the more nearly its axis is perpendicular to our horizon. For hundreds of years to come this season will be March and April for the western sky and September and October for the eastern sky. Any one may illustrate for himself, in two minutes, the *varying* position of this conical axis of light, by revolving a celestial globe, previously adjusted to the latitude of his position. In a minute he can see that the ecliptic makes the largest angle with the horizon when the *equinoxes* are in the horizon; and since the sun's equator is only inclined 7½° to the ecliptic, the projected equator of the sun will make its *largest* angle with the horizon nearly at the equinoxes; and, therefore, we *then see* the luminous cone most nearly perpendicular to our horizon. The apparent breadth of the conical base varies from 8° or 10° to 20° or 25°, as we see it more or less obliquely. It is brightest near the horizon, and fades away by insensible gradations toward the vertex. The light resembles that of the Milky Way or that of the tail of a faint comet. During last week the vertex was near the planet Mars, and a little west of the Pleiades. The accompanying figure will show its form and relation to the sun, our horizon, Mars and the Pleiades, at 7½ hours mean time, February 28. Its *form* is that of an excessively oblate spheroid or lens-shaped body. The *figure* will be recognized as a plane section of the spheroid, made through the center of the sun and at a right angle to our axis of vision.

Many speculations have been hazarded concerning its nature. Kepler thought it might be the solar atmosphere, but La Place showed this hypothesis to be untenable for these two reasons: 1. The solar atmosphere cannot extend beyond the distance at which the centrifugal force, due to rotation, would be balanced by the sun's attraction. This point lies within the orbit of Mercury, or within less than 28° from the sun. 2. The ratio of the axes of the spheroid of atmosphere must be within these limits, Major : Minor : : 3 : 2, while the *actual ratio* is incomparably greater. Cassini thought it might be the blended light of an innumerable number of very minute bodies revolving round the sun. Euler thought it proceeded from the repulsive energy of the sun, after the



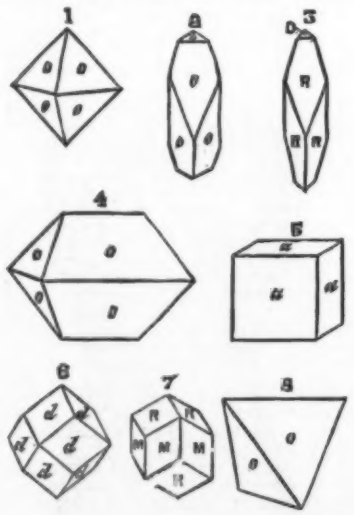
manner of comets' tails. Sir John Herschel says: "It may be conjectured to be no other than the *denser parts* of that medium which we have some reason to believe resists the motion of comets, loaded, perhaps, with the actual materials of the tails of millions of these bodies, of which they have been stripped in their successive perihelion passages." In conclusion, it is but right to state that *trustworthy* observers have testified to the *simultaneous* presence of the luminous cone in both western and eastern sky. See *Gould's Ast. Journal*, No. 84, for May, 1855; also Monthly Notices R. A. S., vol. xvii., and Fourth Ed. U. S. Exploring Narrative, Washington, 1856. Of the same tenor is a communication of Humboldt to the Berlin Academy, July, 1855. Mr. Jones, Chaplain of the U. S. steam frigate Mississippi, during a cruise round the world, had *very rare* opportunities for observing the zodiacal light in all latitudes, and seems to have improved them very diligently. He remarks: "It seems to me that these data can be explained only by the supposition of a nebulous ring, with *the earth for its center*, and lying within the orbit of the moon."—*Western Review.*

STUDY OF CRYSTALS.

By J. H. COLLINS, F.G.S.

(A.) COMPARISON OF FORMS.

THE bounding planes of crystal forms are usually referred to six distinct "systems" of axes, in which the axes vary in length, relative position, and number. The essential characters of these systems are defined in all mineralogical text-books, and will not be referred to here. The object of the present arti-



cle is to call attention to certain resemblances which exist between forms and combinations belonging to distinct systems, and to suggest certain observations on such "deceptive forms" which may be made by students who find themselves involved in difficulties.

1. *The Regular Octahedron* (Fig. 1).—The following forms closely resemble the regular octahedron, and may even be absolutely indistinguishable from it when the several axes happen to be nearly equal, or when the cubical form happens to be somewhat unequally developed or distorted:

a. The tetragonal pyramid, 111.
b. The tetragonal pyramid, 101.
c. The hemihedral form of the ditetragonal pyramid *r* h k l.
d. The rhombic pyramid, 111.
e. The rhombic combination, 101,011.
f. A peculiar combination of a rhombohedron with the basal plane sometimes observed in *chalybite*.

2. *Irregularly Developed Octahedrons.*

a. The acute rhombohedron, which may be cleared from fluor by omitting one pair of faces of the octahedron, exactly resembles the acute rhombohedron sometimes seen in *calcite* and *chalybite*.

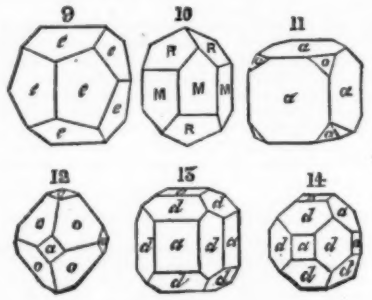
b. The combination (Fig. 2) sometimes seen in spinel much resembles the acute rhombohedron, with basal plane (Fig. 3) observed in *calcite*.

c. The irregularly developed octahedron (Fig. 4) often seen in *alum* exactly resembles the rhombic combination 102,011 (macrodomes with brachydomes), which is sometimes called the rhombic pyramid on square base.

3. *The Cube* (Fig. 5).—The following forms may closely resemble it:

a. TETRAGONAL FORMS.

a. The square tetragonal prism of 1st order, 110,001.
b. The square tetragonal prism of 2d order, 101,001.
c. The hemihedral form of the ditetragonal prism, 1m0,001.



β. RHOMBIC FORMS.

d. The rectangular prism, 101,010,001.
e. The prism, 110,001.
f. The "macrodome," 0kl,100.
g. The "brachydome," h0l,010.
h. The "brachy prism," 1k0,001.

γ. HEXAGONAL FORM.

i. The rhombohedron, when the angles differ but little from right angles.

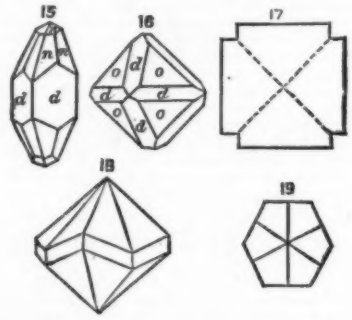
4. *The rhombic dodecahedron* (Fig. 6) closely resembles the hexagonal combination of prism and rhombohedron (Fig. 7) sometimes seen in *calcite*.

5. *The tetrahedron* (Fig. 8) often closely resembles the tetragonal sphenoids which are the hemihedral developments of the tetragonal pyramids, 1*a* and 1*b*. Such sphenoids are often seen in the chalcoprite from the mines near Redruth.

6. The pentagonal dodecahedron (Fig. 9) very closely resembles the hexagonal combination of prism and rhombohedron (Fig. 10).

7. Combinations of the *cube* with the octahedron (Figs. 11 and 12) very closely resemble combinations of a tetragonal prism with a pyramid of a different order—either 110,001,101 or 100,001,111. Here, of course, the resemblance will be more close in proportion as the slope of the pyramid approaches that of the regular octahedron; and this, of course, depends upon the relative lengths of the principal and lateral axes.

8. Combinations of the cube with the rhombic dodecahedron (Figs. 13 and 14) may closely resemble the tetragonal combinations of two prisms and a pyramid—either 110,-100,001,001 or 110,100,111,001.



9. The peculiarly and partially-developed combination of rhombic dodecahedron and deltohedron (Fig. 15), figured by Dana as occurring in *garnet*, might be easily mistaken for the tetragonal combination of prism, ditetragonal prism, and pyramid, 110,1nm,111.

10. The combination of octahedron and rhombic dodecahedron (Fig. 16) closely resembles the tetragonal combination —110,111,101—sometimes found in *cassiterite*.

11. The rhombic macle of *Harmotome* (shown in cross section in Fig. 17) resembles very closely a tetragonal prism.

12. The tetragonal macle of *Rutile* (Fig. 18) closely resembles a hexagonal combination of scalenohedron and prism.

13. The rhombic macle of *Aragonite*, *Chalcocite*, and *Niter* (Fig. 19) closely resembles the hexagonal prism, 110,001, or 120,001.

14. A great many cubical, tetragonal, rhombic forms and combinations are apt to resemble certain oblique and anorthic combinations when their axes are not highly inclined.

15. Cleaved fragments of tetragonal, rhombic, and oblique minerals may be mistaken for cubical forms.

(B.) DETERMINATION OF THE TRUE CRYSTAL SYSTEM.

16. Cleaved fragments may generally be at once distinguished from true crystals by the appearance of the planes, but a crystal form cannot be satisfactorily determined by observations of its cleavages. If, however, there happen to be three sets of cleavages, all forming equal angles with each other, *and all equally perfect and easily obtained*, it will probably belong to the cubical system. Of course the cleavages may often be detected by careful examination—as flaws, etc.—without actually destroying the crystal.

17. Similar planes are usually marked similarly with roughness, striations, curvature, and the like irregularities. Hence, if in a crystal, for example, resembling Fig. 4, we find all the planes of equal brightness, or equally marked with striations, etc., we should be disposed to call it an irregularly developed octahedron; but if the larger planes differed from the smaller ones in these respects we should be probably right in setting it down as a rhombic combination.

In the cubical combinations Figs. 6 and 9 again all the planes will probably be similar in surface condition; whereas, in Figs. 7 and 10 the planes M will probably differ from the planes R.

18. Similar edges and angles are likely to be similarly modified or replaced by other planes. These secondary planes are sometimes very small, but they may often be found on careful examination. Thus, in such a form as Fig. 6, all the edges may be found replaced by small planes if it is truly a cubical form, while the hexagonal combination (Fig. 7) will be likely to exhibit replacements only on the edges between the planes M or the planes R.

It is seldom that a student will find all these indications fail him, but if he cannot get a clew to the real form either from replacements, striations, and roughnesses or cleavages, he may have to examine portions of the crystal optically, in which case he will get very definite results, but generally only by destroying the crystal.

SUGGESTIONS IN THE TREATMENT OF SPINAL DISEASES AND CURVATURE.

By E. H. COOVER, M. D., of Harrisburg, Pa.

THE inception of spinal disease and curvature seldom arrests the attention of the physician until some reflex action takes place demanding his aid. Recently, the subject has attracted notice, through the energy and skill of Drs. J. K. Mitchell, Benjamin Lee, of Philadelphia, and Drs. Jacob A. Wood, Taylor and L. A. Sayre, of New York, all of these making efforts toward suspension, by some means, between the ilia and occipito-vertebral articulation, and to secure some mechanical support or splint to retain the proper position.

Dr. Sayre's apparatus for suspension fulfills the condition, and places the patient under complete control. His plaster of Paris dressing, which I proposed in Case 1, was objected to; hence an endeavor, on my part, to use something less disagreeable. Recollecting that some years since the use of silicate of soda dressing for fractures of the thigh was frequent, I thought that such an application as a substitute for the plaster of Paris might be acceptable and efficient; it proved so. Herewith are presented the results of private practice cases coming under treatment; they are all favorably improving:

CASE 1. Female; white; married; aged 35 years; normal height, five feet nine inches; weight, about 140 pounds; consulted me November 1st, 1876, for supposed uterine disease; upon examination discovered none. She, however, complained of languor and uneasiness in the back, though not enough to cause either herself or myself to think seriously of it. I directed her to take tonics; she used them for several months, with an occasional belladonna plaster. After this period the spine trouble was more prominent, when I used slight counter-irritation, with tonics for several months longer; she became discouraged; discontinued treatment. September 14th, 1877, she again consulted me. Her symptoms were more aggravated; had a haggard countenance, suffered pain, and was anæmic. I noted that she frequently changed her position while seated. Upon inquiry found that she was continually making fruitless efforts to be comfortable.

Examination.—The spine tender, from the seventh cervical to the last dorsal vertebræ, and indications that periosteal inflammation had taken place, with bulging of interosseus muscles; height five feet seven inches. I recommended Dr. Sayre's plaster dressing. She disliked it very much, because some one informed her that it would fill her clothing, etc., with dust. I suggested a course of treatment pursued by me for twenty-six years—to put the patient to bed, and keep a pustular eruption along the spine; where means permitted this was frequently successful, but it was out of the question here. Upon consideration, recommended the application of *silicate of soda*.

Application, September 20th, 1877.—Placed a closely fitting merino shirt upon the patient; suspended her by the pulleys of Dr. Sayre; after extension had been made, a roller bandage of unbleached muslin, three inches wide, was passed around the body downward from the armpits, making "turns" where necessary; then with a paint brush covered the surface with the soda solution; a cap of light tin, muslin covered, wet with the solution, over the crests of the ilia, and a similar brace from over this cap to the axillæ; ran strips of muslin perpendicularly downward over the whole bandage, covering them with the solution; lastly enveloped the trunk in a roller bandage, as at first, varnishing it all over with the soda. Lowered the patient, permitting her to lie down for three hours in a warm room, when the jacket will be dry enough to remove by cutting it open along the spine. Any roughness on the interior is removed by malleting on a shaping block; then remove about an inch from each of the cut edges; finish the inside with flannel; trim the edges, fasten straps or use lacers, and coat over outside with the soda; let dry, when it is ready for use. The patient was again suspended, the corset applied over the merino shirt, as before; it was securely fastened with the straps, and gave instant and permanent relief.

Progress.—On Feb. 25th, 1878, her condition had much improved; suffered no pain, had good appetite; regained her natural height, 5 feet 9 inches; visited Philadelphia and some parts of New Jersey. The muscles of the back have developed so much as to require a new bandage; she has gained 18 pounds. I constructed an improved one, using the merino shirt as before, enveloping it in a bodice of unbleached muslin, extending from the shoulders to three inches over the crest of the pelvis; coated it with soda; placed two covered braces of tin, each one and a half inch wide, from the spine of the scapulæ to the posterior portion of the iliæ, which left a space of from one to two inches between them; then two braces cut along the edge of the bottom and sides, at intervals of one inch, one inch in width, to extend from the axillæ to two inches over the hips, being three inches wide at the top and six inches at the bottom, muslin-covered, varnished with soda solution; wrapped the trunk with a three and a half inch bandage, from above downward, covered with soda solution; stayed with perpendicular strips, wetted with the solution; incased the whole in a second fitted body, painting it with the soda solution when it was completed; this required about three-quarters to one hour. The patient was removed, and in five hours

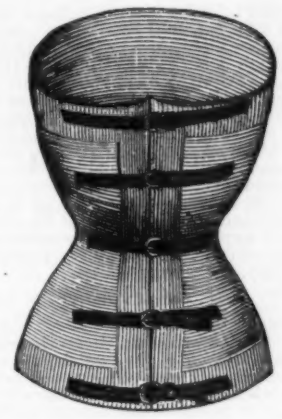


FIG. 1.

the corset was taken off, trimmed and replaced as before. Weight three pounds.

Fig. 1 shows jacket worn five months, retaining its hardness and shape; it became too small, and I was obliged to make another, upon which I improved, as represented in Fig. 2. Weight three and a half pounds.

CASE 2.—Female; white; single; aged 21 (Oct. 19, 1877); of healthy family. She has suffered in her back for a year; dates it from her school life, when between 18 and 19; cannot long retain any sitting position, but must constantly change to secure ease. She had been treated by her local physicians, but no mechanical means used for her relief.

FIG. 2.

Examination revealed tenderness of the spine, extending over the first five dorsal vertebræ; a disposition to lean forward, causing the back to bulge, but exhibiting no curvature. I placed one of the silicated soda bandages upon her; she had relief from pain and is rapidly improving.

CASE 3.—Curvature; female; white; married; aged 30; December 15th, 1877. Suffered, when I first saw her, from what I considered an acute lumbago. She improved slightly, but would relapse. February 3d, 1878, saw the patient; then noticed, for the first time, a depression of the right shoulder, because heretofore I had seen her reclining. Closer inquiry developed the disease. Examination showed

FIG. 3.

the arc to the left side, from one-half to one inch; sensitiveness of the four last dorsal vertebræ, with bulging of the muscles. Some eight months since she fell down stairs, but did not attribute the trouble to that accident. She has suffered from numbness of the side limbs and arms, and used ineffectual remedies. I applied the jacket with much relief and excellent results so far. March 14th, 1878, all the above symptoms have disappeared, and the patient is highly gratified with the results.

March 25th. Patient doing well; suffers little or no pain; has gained in flesh; jacket does not meet, by an inch; opened it in front, widened it one inch, closed solid on the back, and reapplied. I find that opening the jacket in front is quite an advantage, giving firmer support to the spinal column, and more convenient. When a jacket needs widening take a piece of leather the width required; cover with muslin the length of the cut edge of jacket on each side; eyelet-hole the leather part, and let the muslin be long enough to reach over the body of the jacket; wet with soda solution, and after it is dry apply as before.

CASE 4.—Curvature; March 2d, 1878; female; white; aged 60; mother of eleven children; healthy; good family history. Two years ago fell down stairs; recognized pain in vertebræ August last. In January was compelled to go to bed, remaining there until date. She consulted several physicians without any effort being made to afford her proper relief; now she is illy nourished and cannot sleep without an opiate.

Examination exhibited curvature about three-quarters of an inch to the left, superiorly, crossing at the fifth dorsal to the same arc on the right side inferiorly.

Suspended the patient on March 7th; she fainted; in about fifteen minutes revived; had a stool; was again drawn up and the jacket applied, giving much relief; patient slept five hours. This application was made in the presence of Drs. H. L. Orth, C. A. Rahter, Hugh Hamilton, S. R. Gorgas, and my son, D. H. Coover, who rendered assistance.

March 9th. Suspended and reapplied the jacket, which gave complete relief; she rested better the following night than she had for months before.

March 11th. She got out of bed herself, and walked through the room several times without assistance.

March 12th. Readjusted jacket, to remove some folds of undershirt which caused discomfort.

March 14th. Patient doing well; regaining strength, walking through the room frequently during the day without assistance, and slept well without the opiate.

March 23d. Much improved; going down stairs to meals regularly, and walking out without assistance; rests well at night.

CASE 5.—March 18th, 1878. Called to see Mrs. Mary L., aged 62; of good healthy family; weight 80 pounds. She fell two years ago, injuring her spine about the lower dorsal vertebræ. She has suffered pain ever since, is wasted in flesh, anæmic, and has not been able to walk without the aid of crutches, or go up stairs, for eighteen months.

Examination.—Posterior curvature, with permanent anchylosis of the four last dorsal vertebræ.

March 22d. Suspended my patient and applied the silicated soda jacket, not with the view of correcting the deformity, but with the hope of relieving the pain and preventing further deformity. She experienced immediate relief.

March 28th. Patient doing well; suffers little or no pain, and is greatly supported by the jacket. Should the jacket lose the shape while drying, before applying lay cloths, wrung out of hot water, inside and outside, for several minutes, or steam it; then put the jacket on and lay the patient down for several hours, when it will be dry and moulded to the body.

Fig. 3 represents the jacket on the back, showing the curvature. This jacket is opened in front.

Remarks.—The plaster of Paris dressing is in constant danger of cracking and crumbling, requiring the tediousness of reapplication. It is very disagreeable to handle, does not permit removal for cleansing the body so often, and lastly is not attended with as positive success, on these grounds.

The silicate of soda dressing sets nearly as quickly as plaster; does not crack or crumble; can be reapplied readily; allows cleansing of the body frequently, say every four weeks. The corset is always reapplied while the patient is suspended; the braces are essential; the lacing is a very important point in the corset; if you lace so that the draw strings are in the center, the patient can at any time loosen or tighten it, the ends remaining closed, and the support is not weakened, serving the purpose of a dinner pad, when the patient is inconvenienced after eating a full meal. In my hands this corset has afforded invariable relief from pain and gain in health.

The *positional* treatment recommended by Drs. Taylor and Lee does not fulfill the conditions of mechanical support, which is the main point in this cure. The spiral spring corset of Dr. Wood was an effort toward suspension of the adjacent vertebræ, but the apparatus of L. A. Sayre, M. D., is effectual in its operation, and, with the silicate of soda bandage, gives ready relief to this disease and bright hopes of cure.—*Medical and Surgical Reporter.*

ALBUMINURIA IN HEALTH.

THE presence of albumen in the urine, even in very minute quantities, is usually taken as conclusive evidence of such a condition of systemic derangement as deserves to be regarded as disease. Professor Leube, of Erlangen, considering the fact that a trace of albumen is occasionally present in the urine of patients who present no other evidence of renal disease, examined the urine of a large number of men presumably in good health, soldiers on regular duty, in order to ascertain whether albumen could ever be detected in the urine of those who presented no other morbid symptoms. He examined the morning urine of 119 soldiers, and found a trace of albumen in that of five, in one a distinct quantity, in the others merely a faint, just recognizable, trace. In each case the mid-day urine also contained albumen, and in three the amount was larger than in the morning urine. So far the results are not surprising, since they would seem explicable on the theory that these soldiers were suffering from incipient renal disease, which, as is well known, may be unattended by any indication of deranged health. But it was found that albumen was present in 14 soldiers out of 119, whose morning urine had been free from albumen. In all these instances the soldiers had undertaken arduous duty, marches or battalion drill, during the forenoon, but no food or drink had been taken during the exercise. No casts or blood were found in the deposit from the urine. The albumen soon disappeared with rest. This fact seems to show that in apparently healthy men exertion may induce slight albuminuria. This opinion was supported by an instance in which the urine of a soldier was for two days free from even a trace of albumen, but on the third, after a long battalion exercise, it contained a distinct trace, which had disappeared in two or three hours, and was also absent the next morning. In every case in which albumen was present any indication of disease, local or general, was carefully searched for, but

none could be found. The conclusion Leube draws from his observations is that "in the vast majority of cases the urine of healthy persons is quite free from albumen; in rare cases a slight but distinct albuminuria coexists in a completely normal state of system, and is comparatively frequent if bodily exertion precedes the secretion of the urine."

What is the origin of this temporary albuminuria? Our knowledge of the condition of urinary secretion is still too indefinite to permit a satisfactory answer to be given to this question; but it may be explained on either of the current theories of urinary secretion—that of simple filtration of all the urinary constituents through the Malpighian capsules, and that of the specific secretion of the urine by the cells of the tubules. On the filtration theory, the absence of albumen from normal urine is accounted for by supposing that either the walls of the blood-vessels permit the passage of water through them, but retain the colloidal substances, as albumen, or else that albumen passes through the membranes of the Malpighian capsules, and is removed again by the epithelium of the tubules. On the theory that the transpirability of membranes depends on the size of their "pores," Leube fancies that in some individuals these pores may be of such a size as to permit the passage of some colloidal albumen as well as of water: either constantly, under normal pressure, or occasionally, when the abnormal pressure is increased by exertion. On the theory that albumen is pressed out of the blood in the Malpighian capsules, and is removed subsequently by the action of the epithelium of the tubules, the exhaustion of this function of the epithelium, or its inadequacy, affords an equally facile explanation of the observations in question.—*Lancet.*

ACTION OF REMEDIES.

Alkaloids of Opium—Their Action.—The well-determined opium alkaloids now number sixteen. The effect of any one differs from the rest or from that of opium itself. Dr. Isaac Ott (*Journal Nervous and Mental Diseases*) reports a large number of experiments which, added to our previous knowledge, enable him to draw the following conclusions:

1. Cryptopia is narcotic; excites and then depresses reflex action by an effect on the spinal cord, reduces power of motor nerves, abolishes sensation by an action on the spinal sensory ganglia and lowers the heart-beat by an action on its muscular structure.

2. Thebaine is a spinal convulsivant; has no action on motor or sensory nerves or striated muscle. It reduces the heart-beat by an action on that organ, and increases blood pressure by stimulating the cerebral vaso-motor centers.

3. Codeia is a narcotic and spinal convulsivant; produces a veratroid contraction of striated muscle and depresses the heart-beat by an action on the cardiac muscle.

4. Chlorocodide is a tetanic agent.

5. Apocodeia produces vomiting, coma, and death.

6. Narceine is soporific to cold-blooded animals but not to man, and is a spinal convulsivant. It does not destroy the motor nerves, as they act on thrusting a probe down the spine. It produces veratroid contraction of the muscle, and reduces the heart-beat by stimulation of the peripheral end of the pneumogastric.

7. Papaverine is narcotic and convulsivant; the convulsions being partly spinal and partly peripheral, the latter, it is highly probable, from an action on the muscle. It diminishes the heart's contractions by peripheral action on the cardio-inhibitory apparatus. It also causes veratroid contraction of the muscle.

8. Narcotine is non-narcotic, and a spinal convulsivant; produces veratroid contraction of striated muscle, and is a very active agent to decrease the beats of the heart by an action on cardiac muscle.

9. Cotarnine is soporific, and paralyzes, like curare, the motor nerves.

10. Hydro-cotarnine is narcotic and convulsivant.

11. Hydrochlorate of cotarnamic acid is a convulsivant, and paralyzes the pneumogastric.

12. Laudanosine and laudanine are tetanic agents.

13. Morphia is a narcotic and spinal convulsivant. It produces veratroid contraction of muscle and reduces the heart-beat.

14. Oxymorphia has an action like morphia, only weaker.

15. Apomorphia is an emetic; excites and reduces spinal reflex excitability and diminishes the number of cardiac contractions.

16. Meconine is narcotic to cold-blooded animals, but not in doses of two grains by the stomach in man. It causes hyperæsthesia and paralysis of voluntary motion with general relaxation. It also produces a veratroid contraction.

The opium alkaloids all have a dominant action on the nervous system, causing first increased exaggerated functions, and, if the dose is large enough, a paralysis of them. In the warm-blooded animals this action is both on the spinal cord and cerebrum.

TRICHINA SPIRALIS.

AN inspector of meat has recently performed a series of experiments on this subject. He fed a cat, during a period of six months, with meat largely impregnated with the trichina, the animal enjoying perfect health the whole time. At the expiry of that period he killed the cat, and, notwithstanding its previous real or apparent health, 25 trichinæ were found in its body. It is certainly surprising the number was not greater, considering the length of time the cat had been fed on meat infested with the parasites.—*Pharmaceutiche Zeitung.*

[COUNTRY GENTLEMAN.]

HORTICULTURAL NOTES.

CRANBERRIES IN MAINE.

THE transactions of the Maine Board of Agriculture give some interesting facts in relation to the management of the cranberry. In one instance the plantation was set out rapidly, not by planting the rooted plants, but by first cutting them into short pieces in a hay-cutter, and then strewing these evenly over the well-prepared bed of soil. They were then trodden in. They take root freely. If the grass is very thoroughly cleared out on the start and the plants thickly set, it does not give much trouble afterward. Another cultivator, in speaking of the importance of natural protection from frost, said if he were to begin again he would go 200 miles to find a lake of open water, if none were nearer. The largest variety, the Cherry, is too tender for Maine; the Bugle, which is egg-shaped, is fairly safe from the attacks of frost. An interesting statement was given by Samuel Wasson, of Hancock County, to show the advantage of selling the crop at the right time. He had become a little avaricious, and as the purchasers would pay only two and a half dollars per bushel, he kept them till late in winter and sold them for three and a half, the price which he at first wanted. But when they were measured he found to his surprise that they had shrunk so much that he lost more in quantity than he gained in price.

MISSOURI APPLES.

At a late meeting of the Missouri Horticultural Society, Mr. Evans, of Clay County, stated that he has 6,000 trees in his apple orchard, and has tried 75 sorts. He now plants more than one-half Ben Davis—expects to plant 2,000 next year, all Ben Davis. The next most profitable is Rawle's Janet, a regular bearer, and it will always sell for a good price. The Wine Sap scabs badly of late years; so do White Winter Pearmain and Smith's Cider. Huntsman's Favorite promises well; so does Lawver. He would plow an orchard at least once a year; the best crop is corn until the trees bear. He picks early for winter market, as these keep longest. Z. S. Ragan had the Ben Davis in bearing 25 years. He would not set any of this apple, if he were to set 2,000, but would plant all Clayton, if confined to one variety. (This fruit originated in Indiana; is figured and described by Dr. Warder, and appears to be a fine showy sort, keeping till spring.) Mr. R. cultivates his orchard till in bearing, then seeds to clover and turns in swine. If the growth becomes much checked, he plows up, and afterward seeds down again. The fruit picked early keeps longest, but picked later it is better in quality.

THINNING FRUIT.

An orchardist who makes his trees bear a moderate crop every year, of larger and finer fruit than when crowded, gives the following directions for doing the work: A light ladder is used to give ready access to any part of the tree. The branch is held in the left hand, while with sheep-shears in the right every bunch of apples is cut off, leaving a part of the stem of each fruit. This is done as soon as the blossoms have fallen and before the young fruit has attained any size. When this branch is entirely cleaned, the next branch is skipped, and the third cleared of the fruit like the first, and so on until every alternate branch is divested of its fruit. This work is not done on the small limbs here and there over the tree, but on main branches, and equally on both sides of the tree. Of medium-sized trees, an active man will go over fifteen or twenty in a day.

LIQUID GRAFTING-WAX.

This, if properly made, may be readily applied to outdoor grafting, without the trouble of heating, and it is also a good application to wounds made in pruning. The following directions are given by W. W. Tracy: Melt a pound of resin with a pound of tallow, and, when mixed, remove from the stove and allow it to cool till a scum begins to form. Then add a teaspoonful of turpentine. Replace on the stove, and add seven ounces of a mixture of two parts of alcohol and one part of water, stirring briskly, and taking care that the alcohol does not burn, as it will if too hot. Stir till of the consistence of honey; keep corked, and apply with a brush. If it gets too hard, remelt, and apply a few drops of turpentine and of alcohol and water. It hardens after applying.

PROFITS OF FRUIT GROWING.

The first question to ask by any one intending to raise fruit for profit is whether the intended locality is one naturally well adapted to the business. To attempt it on unsuitable land and under adverse influences is worse than money thrown away. To show what may be done in a favorable locality, we give in substance a few of the statements made at a late meeting of the South Haven, Mich., Pomological Society, in a region possessing many advantages, conspicuous among which is the protecting influence of Lake Michigan. N. Phillips furnished statements from some of the leading fruit-growers of that place, according to which the orchards gave a net profit of $243 per acre. Some of the peach orchards yielded double the amount. L. H. Bailey would rather raise apples and peaches than wheat at $1.60 per bushel or corn at $1 per bushel. He applied all the manure he could procure to his trees. Mr. Hoag said the fifty apple trees which he put out at an early day paid him 200 per cent. A. S. Dyckman had 20 acres of peach orchard—the whole expense of cultivating which was $1,500 per annum. He picked 20,000 baskets of peaches the past year. Apples were profitable, but small fruits more so. His profits from farming were small compared with fruit raising. A. Healey sold $2,500 worth of peaches last year from 14 acres, and, deducting $300 paid hired help, had $2,200 left. Others had been more unsuccessful, and received small profits, which was accounted for by some of the members by a want of manuring or good cultivation, or by planting all the land to trees, and leaving none for farming or manure making.

TAR WALKS.

A late writer thinks that to make walks with gas-tar as a component part is the only effectual way to exclude weeds, short of hand-picking. But many tar walks are badly made. In the first place, the foundation and drainage must be perfect. Ornamental tiles should be placed at the sides in perfectly even lines, at such a level as to allow three inches thick for the tar-paving Two inches of coarse tar-paving should be spread first, made perfectly even, and rolled with a heavy roller, so as to impart solidity. A fine layer is then placed on, one inch thick, with equal care as to evenness. The gravel or finely-crushed stones for this purpose must be perfectly clean, and, when heated, mixed with the hot tar. When hardened, the surface is painted over with tar, and a finish given with fine gravel or pulverized shells, made even with the roller.

ENRICHING ORCHARDS.

J. C. Plumb, of Milton, Wisconsin, a veteran fruit cultivator, urges the importance of good soil and good cultivation in young orchards. The whole surface should be kept mellow with some hoed crop early in the season, with little or no culture late in summer and in autumn, to favor the ripening of the wood for the cold winters of that region. When in full bearing, the orchard may be seeded to clover, and each successive crop turned under every two years, with a light dressing of manure in the alternate years when not plowed. Buckwheat does well if left to decay on the ground. One plowing the following May, and harrowing, will give a self-seeding.

AN ILLINOIS ORCHARD.

J. S. Stickney gave an account at a meeting of the Wisconsin Horticultural Society of the orchard of A. R. Whitney, of Franklin Grove, Ill. He has 160 acres in orchard—100 acres in bearing. The crop in 1876 was 25,000 bushels. He raises crops among the trees until they require the ground; then an occasional plowing and pasturing with sheep. He expended $1,000 in one year in destroying canker worms, to which he gives no quarter. His remedy is whale-oil soap, 6 pounds to 40 gallons of water, one gallon to a tree. His sheep take care of the codling moth.

APPLES FOR WISCONSIN.

The Wisconsin Horticultural Society gives the following lists of apples for that State: For extreme hardiness only—Tetofsky, Duchess of Oldenburgh, Haas, Plumb's Cider and Fameuse. For general cultivation—Tetofsky, Duchess of Oldenburgh, Haas, Plumb's Cider, Fameuse, Walbridge, Red Astrachan, Utter, Westfield Seeknofurther, Ben Davis, Tallman Sweet, St. Lawrence, Willow Twig, Pewaukee.

BLACKBERRIES.

An Illinois cultivator says that, on taking the New Rochelle and Kittatinny blackberries to market and placing them side by side on the same stand, the Kittatinny will outsell the other twice over, on account of its fine glossy black appearance. It is also much the hardiest, and he finds it unsurpassed in quality. This is the vote of many Western cultivators, but its liability to rust is ruining it in several localities.

MANAGING A LAWN.

THERE are various ways of treating a lawn, depending upon the nature of the soil and the locality, and the convenience of securing materials for dressing. Of course the soil is to be drained, either naturally or underlaid with tile. Our drained clay soil is always more or less benefited by gypsum, especially our drift loams. It has a strong tendency to bring in white clover, which is native to this soil, and one of our favorite plants for a dooryard or lawn, usually associated with the small June grass (*Poa compressa*), the two together making a perfect turf, and one of the softest and finest of coverings, of a dark blue-green, and comparatively slow of growth, requiring, therefore, less frequent cutting, and looking better after each mowing. Where the soil originally has been well and deeply enriched, the sulphate alone, if a good article, will be all that is needed, applied, if finely ground, once a year early in the spring ere the grass pushes, or every other year if somewhat coarsely ground. The last cutting in the fall should be omitted, leaving the growth for winter protection.

Where, however, this kind of soil has not been properly attended to, lacking, as is too common, in fertility, road dust should be applied in addition to the plaster. Apply in the fall. It is best, and decidedly, to secure it in roads that are much traveled, where there is much horse dung, which gives it its chief value. The cost is only the labor of gathering and applying. This is a most excellent means of securing a thick green turf and continuing it, and will do well on all kinds of soil. It serves in a measure to protect the plant during the winter, and is also a guard against the heat in summer, as it covers the cut grass which has accumulated, forming thus a sort of air chamber, and introducing earth to the vegetable material. The writer depends upon this as his chief top-dressing, preferring it to any other.

But there is more or less complaint of a thin set of grass. The remedy is simple and immediate—apply sour milk. A gallon to six feet square of ground will in a few weeks cover with a thick dark growth. At the end of six or seven weeks repeat. This will establish a sod. After this road dust and plaster will do the rest.

A successful way practiced here is to give a coat of manure in the fall (which protects), and rake off early in the spring, leaving the finer and better parts of the manure, the raking loosening the soil a little, and serving as a hoeing to the plant. This will do to establish the growth; but the manure is not a pleasant thing to have on a dooryard or lawn. Follow in the fall with road dust, and with plaster in the spring, and the effect will be all that can be desired.

I have spoken of drainage. A lawn should never be made without it. Plow and subsoil deeply, and work in manure. If clay, it is best to cart on sand or gravel, and work this in also. A mere loosening of the original soil will do only for one season. The materials named will keep it more or less in a porous condition. But it wants an equal distribution, equally firm in all parts, so as to secure a permanently even surface. Finish with a good coat of rich manure, and leave this on until well washed out. Then mix with the surface soil, using cultivator and harrow well, where the soil is composed largely of clay. Where sand predominates, pulverized clay, if such can be found, may be worked in as the sand and gravel were worked in the other soil, and finished with manure, and a manure that has all the qualities necessary to grow the grass. Ordinary barnyard manure will do this. But it must be well worked into the soil after saturating it on the surface. Such a soil will grow anything, and grow it at once, without the usual doctoring and nourishing and delay.

But what to sow is usually as difficult as the preparation of the ground itself. Where there are less shade and good chances for the sun, the little June grass mentioned is the best, forming a fine velvety covering with its thin blades and many of them. Besides it is very early, standing the winter well. For a dooryard or small lawn this is the grass. A thicker, softer turf can be formed by adding the white clover, and sowing the two together, or the ground may be sodded over if an immediate green is desired.

Where there is a large extent of ground, somewhat varied in its surface, or a slope well studded with trees, orchard grass is appropriate, as its large leaves and rich appearance harmonize with the strong, picturesque character of the scene. But it must not be kept shorn, as this would destroy the effect intended, presenting a gray, naked appearance, with coarse stubble. Clip it once or twice early in the season (it is a rapid grower, and will soon spring up), and then give it full play. It will form one of the finest varied mats imaginable, composed of small circular tufts, with long leaves, glossy and rich, whose slight undulations are in keeping with the varied character of the rest of the lawn. Orchard grass does well in the shade; but it wants a rich soil, richer than any other grass. It will then, and then only, thicken and hold its own. A month or more after the spring clipping, during which time it exhibits a very fine appearance, it will begin to push forth stalks. It then should be cut, the grass dried and removed, making a superior hay. Two such cuttings (aside from the spring clipping) are all that are necessary during the season, leaving the last growth for winter protection. As the two cuttings have withdrawn considerable fertility, the loss must be supplied, and this may be done in the fall by a coat of manure or road dust. As a rule with lawns, an occasional dressing of lime is a benefit, as it acts advantageously on the vegetable material which has been accumulating. Apply in the fall.

In preparing ground for a lawn, the best way is to make a fallow for it. This will give a chance to work in manure,

and time to decompose and unite with the soil; also to work in sand or clay as wanted, and thus improve the texture. It also admits of underdraining if required and not yet done. The last work is a coat of manure in the fall, leaving the ground unsurpassed in the spring for early working with the harrow and the reception of the seed. Sow plenty of seed, sow evenly, and follow with roller or light harrow. A lawn is intended to be permanent, and therefore requires pains taken with it, not only in the start when established, but to keep it established. It then becomes the greatest attraction of the homestead.—F. G., *in Country Gentleman.*

THE VALUE OF HEN MANURE.

SHOULD all the droppings from the roosts by hens be carefully saved in barrels, and every spring and fall this manure be composted with any good soil or muck from swamps, and kept a few months, its value for any crop is equal to Peruvian guano, and may, I think, be estimated at fifty cents per fowl per annum. From fifty hens I save about ten barrels of the pure hen guano during the year. What I save from November to April I compost in the spring with soil. First, I spread soil in a circle to the depth of three or four inches, then I spread hen manure about an inch deep; then I spread another layer of soil, till the heap is completed, using about four times the bulk of soil that I do of manure, the last layer being soil. The top of this compost heap I make flat to catch the rains; then I cover with any refuse or straw, then place some sticks of wood or boards against the covering to keep it in its place, and in two or three months it is ready for use, having become thoroughly incorporated with the soil, but as the season for planting is then nearly past, I leave the heap until the next season, when I use it with what I compost in November. Perhaps it would be better to make a compost in March, where the climate will admit, and use the manure for crops planted the last of May or early June; but I can discover no loss by keeping it till the next season. A gill of this compost in a hill of corn will be equal in effect to half a shovelful of manure.—*Woodbury News.*

WHITE AND YELLOW CORN.

MR. J. AVERILL, of Paw Paw, Mich., asks an answer from your correspondent to the following question: "What is the relative value of white and yellow corn for feeding purposes, and especially for the fattening of pork?" I am sure I do not know, and I do not know any one who does know so fully that we can accept his knowledge with entire confidence that he is correct; and for the reason, in the first place, that we have no accurate analyses of Indian corn to the extent necessary to enable us to decide whether white or yellow corn contains the greatest amount of fattening or carbonaceous substances. In the second place, no doubt that soil, situation, climate, and latitude affect Indian corn, as they are known to do wheat; and Indian corn, like wheat, would be pretty sure to take up more mineral matters from the soil, and more nitrogenous ones from the soil and atmosphere together, on strong, rich land, and under a long, warm summer climate, than on a poor soil, in a short, cool summer. We know most Southern corn absorbs more water in cooking than Northern corn, makes better bread, and, if we accept the accounts of travelers as facts, we know the national tortillas of the Mexicans to be made of Indian corn solely, and, after being baked, to be tough and leathery, as buckwheat cakes are.

So far as Illinois is concerned, nine tenths of all the corn grown is of the yellow varieties, the preference for white corn being confined to the southern part of the State; but those eaters of corn bread having Southern antecedents are sure to choose white corn meal, as those of Eastern are quite as sure to select yellow meal for culinary purposes. If our information is correct, the larger share of the corn grown in the South is of the white varieties, the white ones only being used for bread, as the yellow ones are cultivated and preferred in the North. Generally speaking, then, on these grounds I think it may be safely assumed that Northern corn contains most oil and starch, and Southern corn most mineral and albuminous matter; that the former will produce the largest increase of adipose matter in the shortest time, and the latter will increase the size of the bones and muscles most in the same way.—*Country Gentleman.*

LAC AND THE LAC INSECT.

AT the usual monthly meeting of the Metropolitan Scientific Association, London, Mr. W. K. Marriott gave interesting particulars of his recent researches into the natural history of the lac insect, concerning which so little has been hitherto known that specimens could not even be obtained from mounters of microscopic objects. The lac insect is a species of coccus, which secretes the gum known to commerce as gum lac, and upon opening any mass of this substance entombed insects are found as well as cavities formerly occupied by escaped members. He had dissolved stick lac in spirits of wine, and the released insects, mounted, were exhibited in detail at the meeting. The young insect is born alive about July, and at once finds its way to some part of the tree on which it fastens, and, absorbing the juices of the tree, begins to secrete lac. The young at this period are of elliptical outline, obtuse toward the anterior, and have two eyes and three pairs of legs, besides two other protuberances which, in the case of males, develop into wings. Up to the age of a month no difference in sex is observable, but afterward remarkable divergences take place. Supposing it to develop into a female, then in eight or nine weeks it loses its eyes, antennæ, and legs, but its head and posterior organs become abnormally enlarged. The mouth shows several hollow tubes, and the protuberances on each side throw forth extensive tracheæ. The female, it may be added, is permanently incarcerated in the gum. If a male is developed, the short antennæ become long, the eyes protrude, and two other eyes appear on the ventral side of the head, while the legs become noble limbs. If born in July the male has no wings, but if born later he possesses them, this arrangement being necessary from the fact that he has to seek the female under different circumstances. His cell is, of course, provided with an aperture from which he can issue. The proportion of males to females has been estimated at 1 to 5,000, but this is open to question, as some masses examined by Mr. Marriott showed the males to actually preponderate. The young are born in July, and by August all are secreted, and in September the females are impregnated. About September 20 the females concealed under the lac throw out great quantities of a cottony-looking substance through the three apertures. The pouches now contain ova filled with globules containing oily matter, which is no doubt the food of the young, and globules containing coloring matter. The young issue from the rectum, and, if crushed at this time, yield a scarlet dye. The insects do not appear to frequent any special variety of tree, but possess the power of changing any kind of juice into gum lac. It seems probable that the lac is secreted through the orifices in the skin, because the insect, when examined, has numerous perforations, giving him an appearance similar to the Foraminifera.

In the course of the discussion which ensued, the President pointed out the remarkable manner in which the original Sanskrit term for gum lac—namely, Laksha—had been followed by the allied languages—German: Lack, gummilack; French: Lacque, gomme lacque; Italian: Lacca, gommalacca; Spanish: Goma laca; Russian: Laka, gummilak; Arabian: Laak; Hindostanee: Lak'h. The various details of the lac insect exhibited had been mounted with remarkable success by the librarian, Mr. W. West.

NEW METHOD FOR THE ESTIMATION OF SULPHUR IN ORGANIC COMPOUNDS.

By M. W. ILES and C. FAHLBERG, Chemical Laboratory Johns Hopkins University.

CONSIDERING the number of methods which have been proposed, as for example that of Liebig, Kolbe, Debus, Russel, Carius, Warren, and Sauer, Mixter, Wiedel, and Schmidt, etc., one would naturally suppose that nothing was to be desired for the analysis of sulphur in organic substances.

We recently had occasion to make a number of determinations of sulphur in organic compounds, and were led to investigate the various methods proposed, and to carefully try a number of them—some of which were found not to be of general applicability, others gave results too high or too low, while others required complicated apparatus, thereby causing opportunity for unavoidable errors.

We will not at present discuss the relative merits of the various methods, but will proceed at once to a short statement of our own, which we hope, for its very simplicity and accuracy, will commend itself to the attention of chemists.

Fuse from 30 to 50 grms. of pure stick potassium hydroxide in a large crucible, preferably a silver one.

Introduce from 0·1 to 0·5 grm. of the substance upon the solid potassium hydroxide. If the substance can be conveniently transferred to the crucible without the use of water it has been found best, as the presence of water makes the operation unnecessarily long.

The mixture is then gently fused until the potassium hydroxide has lost all of its water, and the liquid has assumed a quiet state. This operation is not a violent one, but water and gases are gradually evolved.

Heat is applied gently at first, and increased as the operation proceeds.

It is immaterial in what form the sulphur exists in organic compounds, since the sulphur in all cases will be transformed into an oxygen compound, and will be found combined with the alkali, which is present in excess.

In this operation potassium sulphite will be formed. In no case was there a trace of the lower oxides of sulphur detected, although in some cases there may be produced a minute trace of potassium sulphate.

The fused mass is then treated with water, filtered if necessary, and to the clear solution is added a saturated solution of bromine water, until the liquid has assumed a slightly yellowish tint. Hydrochloric acid is then added to acid reaction, thereby producing oxygen and bromine *in statu nascenti*, both of which are powerful oxidizing agents.

The mixture is then heated, gently at first, until all the bromine has been expelled. To the clear solution barium chloride is added, and treated as usual for the determination of barium sulphate.

As will be seen from the above statement, we have a mixture, after the addition of bromine water, consisting of potassium bromide, potassium bromate, and potassium sulphite.

If now to this solution hydrochloric acid be added, there will be a liberation of hydrobromic acid, which will act upon the bromate, in a manner similar to the incomplete action of hydrochloric acid upon chlorates in solution.

Furthermore, we will have a complete decomposition of the bromate by hydrochloric acid, by which there will be formed also nascent oxygen and bromine.

To illustrate the correctness of this method, a number of analyses have been performed, which will be given in a later and more extended communication.

It is our intention to employ this mode of oxidation in a number of cases which do not bear upon the question under consideration.

We wish to direct the attention of chemists to the fact that the potassium hydroxide, as ordinarily found in this country, and sold as chemically pure, contains a *very* large amount of potassium chloride. In such cases it is not advisable to use a silver crucible, as the silver is thereby attacked, forming chloride of silver.

BALTIMORE, April 17th, 1878.

AMMONIA.

AT the present day its main sources are the ammoniacal liquor produced in the manufacture of gas—a source which is so polluted that it is next to impossible to obtain pure products from it. Formerly the ammonia found in commerce could be obtained sufficiently pure, the manufacture for a long period having been conducted on the same principle and originally produced from the soot collected from the burning of one form of animal excreta—camels' dung—in Egypt near the temple of Jupiter Ammon (whence we get its name). It was afterward obtained from putrid urine, and also by the destructive distillation of animal substances. At the present time we may be said to depend entirely upon three sources for our supply—the gas liquor already pointed out, the boracic acid layers of Tuscany, and such animal matter as bones, hartshorn, etc.

The ammonia from gas liquor, which forms the largest portion of our supply, is, perhaps, the most impure, being contaminated with many of what are termed the compound ammonias, together with other matters of an empyreumatic nature.

The dry distillation of animal matter yields a product more easily purified, its main impurities being empyreumatic.

The finest and purest kind of ammonia is, however, that obtained as a by-product in the manufacture of borax. When soda is added to the boracic acid, ammonia in a state of great purity is evolved, and is made use of for the production of ammonia solution and ammonia carbonate, which are met with in commerce under the name of "volcanic ammonia." This is the purest obtainable in the usual way, and is what we would always recommend our readers to employ for all delicate work.

Solution of ammonia is most commonly met with in an almost saturated form of specific gravity ·88, a fluid drachm containing 15·83 grains of pure ammonia. It is liable to become contaminated with carbonate, lime, metals, sulphates, chlorides, and sulphides, its freedom from which would be shown by the absence of precipitate or turbidity upon the addition of solution of lime, oxalate or hydrosulphuret of ammonia, or ammonio-sulphate of copper, and, when treated by excess of nitric acid, by the absence of turbidity upon addition of nitrate of silver or chloride of barium. The solution should further be free from color, which, in conjunction with a peculiar smell, indicates the presence of empyreumatic oil.

A well-known quality of the solution is its power of dissolving many salts and oxides insoluble in water—notably silver oxide and bromide.

The carbonate of ammonia, so called, is, in its parent form, perhaps more correctly called the "sesquicarbonate," there being other carbonates containing less and more acid. It is obtained by sublimation in cakes about two inches or more thick, which, when quite fresh, have a clear, translucent appearance, rather fibrous than crystalline in texture. Exposed to the air the pieces decompose rapidly, ammonia being evolved and the acid carbonate left behind. This decomposition is shown by the change in appearance of the carbonate; it becomes quite opaque, a few minutes' exposure to air being sufficient to produce a visible alteration. Even when kept in well-stoppered bottles it will gradually alter, and, in consequence, it is always necessary when making a solution to remove all the opaque crust, and use only the clear, transparent inner portions of the lumps.

The composition of the sesquicarbonate is open to considerable doubt, authorities differing very considerably from one another; the opinion of Rose, that it varies according to its mode of preparation, seems most likely. It is stated that repeated sublimation diminishes the proportion of the sesquicarbonate in the condensed product. However, by the authority referred to by us recently in our article on standard solutions, etc., it is required that fifty-nine grains dissolved in an ounce of distilled water should be exactly neutralized by the 1,000-grain measure of the oxalic acid solution; 1·5 grain of it is also dissolved by seventeen grains of citric acid.

It is soluble in water at 13° C., in the proportion of twenty-five parts to one hundred; at 17°, thirty parts; at 32°, thirty-seven parts; at 41°, forty parts; and at 49°, fifty parts. At a higher temperature than the latter the salt is decomposed, carbonic acid being evolved, and a solution of the normal carbonate being left behind. Hence it is obvious that the solution kept for developing should not be made by boiling water. This solution when exposed to air gradually decomposes, the acid carbonate being produced; it should be kept in tightly-stoppered bottles, a little wax or paraffine melted over the stopper being a good safeguard for either the cakes or the solution if they are to be kept any length of time. We repeat it is most desirable to use only the clear, unchangeable pieces for solution, and if possible always to obtain the "volcanic ammonia."

The ammonia more commonly sold is liable to an impurity which is especially obnoxious to photographers—nothing less than hyposulphite of ammonia. When the sesquicarbonate is prepared from either a sulphate or a chloride containing a sulphate this impurity is most likely to be met with, and it is not always entirely got rid of by resublimation. It may be detected by the addition of nitrate of silver to a solution of the carbonate neutralized by acetic acid, the well-known white precipitate turning to black even in the dark easily showing the presence of the sulphuric acid Such samples should be rejected entirely—*British Journal of Photography.*

SEPARATION OF CRYSTALLINE SILICIC ACID.

By E. LAUFER.

THE author takes advantage of the property of phosphoric salt to dissolve metallic oxides at a melting heat, and to isolate silicic acid from silicates without attacking quartz. To the finely powdered material, weighed in a platinum capsule, phosphatic salt was added in a larger quantity than was required for the solution of the silicates supposed to be present, the crucible not being more than half full. It was gradually and cautiously heated in the air-bath, then melted, the heat being finally urged with the blast till the mixture was in tranquil fusion. The cold mass was easily separated from the crucible, and was then boiled for a length of time with dilute hydrochloric acid, washed by decantation, and filtered, the silicic acid being then extracted from the residue with boiling soda.

DETECTION OF BUTTER ADULTERATIONS.

By C. HUSSON.

THE author's process is too lengthy for a full description. He places in each of a number of test-tubes 10 grms. of the whitest castor oil, and adds to one 1 grm. of the sample to be examined, and to the others 1 grm. each of the various fatty matters with which the butter is likely to be sophisticated. The tubes are then plunged in the water-bath, and the appearances presented at different temperature are noted. The mixtures are then treated with cold alcohol at 90 per cent., the emulsions formed are filtered, the residue washed with more alcohol, and dried in a current of air. One grm. of tallow thus leaves a deposit of 1·20 grm., while pure butter yields only 0·70. The author also dissolves fats in equal weights of glycerine, heating, agitating, and treating the emulsion formed with an equal weight of alcohol at 90 per cent., and of ether at 66 per cent. The tubes containing these mixtures are placed in the water-bath, maintained at 25°, and the strata of liquid produced are examined. With pure butter the lower stratum is slightly opalescent, the more decidedly the more milk is shut up in its texture. With margarine lard, tallow, etc., this phenomenon is, of course, wanting. The tubes are afterward withdrawn from the water-bath, let cool to 18° or 20°, and the deposits produced are examined with the microscope.

ON BENZ-ERYTHREN.

By G. SCHULTZ.

THE author obtained benz-erythren among the products formed by passing benzol through an ignited tube. It is insoluble in water, almost insoluble in alcohol, scarcely soluble in boiling glacial acetic acid, and in cold benzole, though it is readily taken up by the latter solvent with the aid of heat, and crystallizes on cooling in small shining leaflets, which melt at 307–308°. It is not identical with Rasenack's parachrysen.

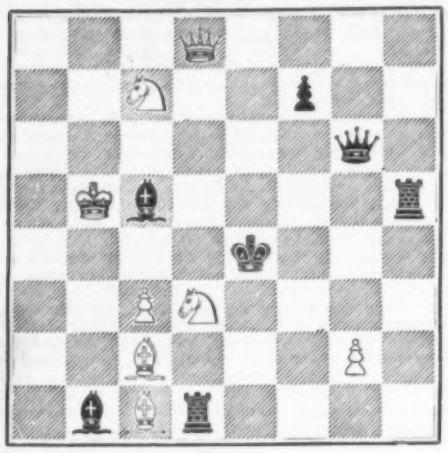
SCIENTIFIC AMERICAN CHESS RECORD.

[All contributions intended for this department may be addressed to SAMUEL LOYD, Elizabeth, N. J.]

PROBLEM No. 84. BY W. MERIDITH.

Second Prize in Dubuque Tourney No. 3.

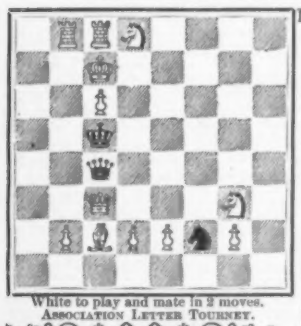
Black.



White.

White to play and mate in three moves.

HERR HORWITZ, OF LONDON.



White to play and mate in 2 moves.
ASSOCIATION LETTER TOURNEY.

LITTLE as our problemists and solvers favor end games or lengthy positions, the popular tendency now being for positions in two and three moves, yet for the student or theoretical player there is a fascination and preference for the study of end games that ordinary problems do not excite.

In connection with the name of Kling, that of Horwitz will ever be remembered as one of the most thorough, scientific and prolific analysts of the "higher mysteries of our royal game," as these celebrated authors were pleased to term it in the dedication of their work to Mr. Staunton.

The names of Kling and Horwitz have been familiar to the chess public for half a century, and have long been classed with the old masters, whose works have become the highest authority, and to whom we are indebted for the present perfection in the art of composition. Of these two co-laborers Horwitz is yet living, well advanced in years and enthusiastic for his art, still adding to the monument that is to perpetuate his memory. We have had many pleasant interviews, and found him to be of a genial, gifted, and withal most modest nature—an artist and musician by profession, with talents that might have won a lasting niche in the temple of fame had they been pursued with the same tenacity displayed in his analytical researches.

As a player Mr. Horwitz ranked with the foremost, and all modern works contain specimens of his skill, but like a true problemist he built his fame upon a more lasting foundation.

In conclusion we give the following enigmas which we recollect to have seen in Kling and Horwitz's work on end games, published in 1851.

ENIGMA No. 50.—BY KLING and HORWITZ.

White.—K on K Kt 6, B Q B sq, Kt K R 5.
Black.—K K R sq, B K 2.
White to play and win.

ENIGMA No. 51.—BY KLING and HORWITZ.

White.—K on Q B 6, Q Q B sq.
Black.—K Q R sq, Q R B 4, Ps Q R 4 and Q Kt 4.
White to play and win.

BROWNSON'S DUBUQUE TOURNEY NO. 3.

IN continuing the records of the interesting Problem Tournaments inaugurated by the indefatigable Prof. Brownson in his magazine, we find that his tournament book contains the winning problems but is sadly deficient in regard to data and times of competition. It seems to have been a most curious affair, as among the competing problems we find many strange and unnatural conditions, as shown by the following *cagarie* by Shinkman, which received the first prize:

ENIGMA No. 52.—BY W. A. SHINKMAN.

First Prize in Dubuque Tourney No. 3.

White.—K on Q R 2, Rs Q Kt 5 and K 8, B K 4, Kts Q Kt 8 and K B 5, Ps Q Kt 4, K R 3 and 4.
Black.—K K B 5, Ps Q R 6, Q Kt 2 and K R 4.
White to mate in four moves *without moving the B.*

The second prize was awarded to W. Meridith, a clever composer of whom we would like some information, as his name has always been supposed to be a *nomme de plume* assumed by Shinkman.

The third prize was awarded to J. B. Cherriman, and the fourth to Prof. Agnel, of West Point, one of our most prolific and clever composers, who has not been heard of for many years, and it is but a short time since we learned that this gifted composer and author committed suicide owing to domestic troubles.

ENIGMA No. 53.—BY H. R. AGNEL, of West Point.

White.—K on Q R 2, Q Q 8, R K Kt 4, Bs Q B 5 and K R 5.
Black.—K Q B 7, Q Q B 2, R Q R 2, B K 8, P K B 7.
White to play and mate in two moves.

THE NEW AUTOMATON CHESS PLAYER.

MR. C. G. GUMPEL, of London, has invented a new mechanical chess player, of which both the construction and performance eclipse those of any previous chess-playing machine. The talented inventor has named his mechanism "Mephisto," and has been inviting the leading players to a series of *séances* at his house in Leicester Square in order to test the merits of his invention before exhibiting it at the forthcoming Paris Exhibition. We select a specimen game played with Mr. Tinsley, which is a remarkably brilliant game; most of the leading players have succumbed to "Mephisto's" prowess. The question among chess players, therefore, is not so much how the combinations are formed or the moves conveyed to the concealed director of the game, as who is the skillful player who runs the machine, for among players not one could be found to place any credence in the claims of the inventor.

The figure is entirely too small to admit of a player being concealed within, as in all previous chess automatons, being merely a slim little figure sitting before an ordinary chess table, entirely disconnected from surrounding objects, without the possibility of a person being hidden near him. The figure is dressed in gorgeous red velvet trimmed with black, pink hat with black border and two magnificent pink feathers, his hand encased in a black kid glove.

The mechanism is said to be most perfect, and the head makes the most graceful and natural movements. Where the player is located, and how the moves, as well as necessary mechanical force, are communicated to the machine, is of course the secret of the inventor, but in this age of electricity, telephones, phonographs, etc., it is but natural to suppose that the old automaton of Maelzel has been improved upon.

HERR HORWITZ.

[*Two Knights Defense.*]

MEPHISTO.	MR. TINSLEY.
WHITE.	BLACK.
1. P to K 4	1. P to K 4
2. Kt to K B 3	2. Kt to Q B 3
3. B to B 4	3. Kt to K B 3
4. Kt to Kt 5	4. P to Q 4
5. P x P	5. Kt x P
6. Kt x B P	6. K x Kt
7. Q to B 3 ch	7. K to K 3
8. Kt to Q B 3	8. Q Kt to Kt 5
9. Q to K 4	9. P to Q Kt 4
10. B to Kt 3	10. B to Kt 2
11. P to Q 4	11. B to Q 3
12. P x P	12. B to B 4
13. Q to Kt 4 ch	13. K to B 2
14. B to Kt 5	14. Q to K sq
15. Castles Q side	15. Q to K 3
16. Q to B 3 ch	16. K to K sq
17. Kt x Kt	17. Kt x Kt
18. R x Kt	18. Q to K Kt 3
19. P to K 6	19. R to K B sq
20. Q to B 7 ch	20. R x Q
21. P x R ch	21. K to B sq
22. R x B	22. P to K R 3
23. B to Q 2	23. Q x Kt P
24. R to K sq	24. Q x B P
25. R x B P	25. Q x R ch
26. B x Q	26. P to Kt 3
27. B to Kt 4 ch	27. K to Kt 2
28. P queens, mating.	

THE following curious little game was played not long since at the Circle des Echecs, St. Petersburg:

M. SCHEIFFERS.	AMATEUR.
WHITE.	BLACK.
1. P to K 4	1. P to K R 3
2. K Kt to B 3	2. P to Q R 3
3. B to Q B 4	3. P to Q Kt 4
4. B x P ch	4. K x B
5. Kt to Kt 5 ch	5. K to K 3
6. Q to K Kt 4 ch	6. K x Kt
7. Q to K B 5 ch	7. K to Q 3
8. Q to Q 5 mate.	

IT is remarkable that Howard Staunton, the great English chess player and Shakespearean scholar, should be quoted as authority for saying that no allusion whatever to our royal game appears in any of Shakespeare's works.

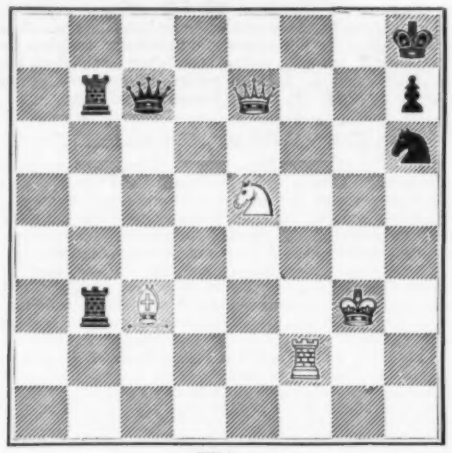
Katharine, in the "Taming of the Shrew," makes the following capital chess pun:

"I pray you, sir, is it your will
To make a *stale* of me among these *mates?*"

PROBLEM No. 85. BY J. B. CHERRIMAN.

Third Prize in Dubuque Tourney No. 3.

Black.



White.

White to play and mate in four moves.

SOLUTIONS TO PROBLEMS.

No. 78.—BY GEO. E. CARPENTER.

WHITE.	BLACK.
1. Q to K 6	1. K moves
2. Mates.	

No. 79.—BY W. A. SHINKMAN.

WHITE.	BLACK
1. P to Kt 5	1. K to B 5
2. B to Q 7	2. K to Q 4
3. B to B 5 ch	3. K to B 5
4. B to K 8	4. K to Q 4
5. B to R 5	5. K to B 5
6. B to K 2 ch	6. K to Q 4
7. B to Q sq	7. K to B 5
8. B to Q R 4	8. K to Q 4
9. B to Kt 3 mate.	

LETTER "B."—Association Tournament.

WHITE.	BLACK.
1. Q x B ch	1. K to Kt sq
2. Kt x R ch	2. K moves
3. Q to R 3 mate.	

ENIGMA No. 46.—BY V. PORTILLA.

WHITE.	BLACK.
1. K to Kt 2	1. K moves
2. Q to K Kt 3 ch	2. K moves
3. Mates.	

EN ROUTE.

SINCE our last issue we enjoyed a surprise in the shape of a midnight visit from Mr. Mason, who informed us that he had just received a ticket for Europe and had but ten hours to prepare for his journey.

Our offer of last week, which was made in conjunction with Dr. Moore, who goes halves in all our ventures, was carried out, and we trust that the projectors are making proper efforts to give Mr. Mason's admirers an opportunity of contributing their mite toward the expenses of the trip. In order to give it a national character we suggest that the New Chess and Problem Association assume the responsibility of the expenses of our delegate; at all events we vote that the playing fund be devoted to this object instead of holding a tournament.

PHILIP II., of Spain, is said to have conferred the bishopric of Segovia on Ruy Lopez, in recognition of his skill at chess.

A correspondent of the *British Chess Review* says:

"How often, after having pored over some perplexing and intricate termination till we were almost tempted to resign the effort in despair, when at last the composer's idea has flashed into our mind, we have risen with consciousness of our extreme cleverness and sagacity."

THE first game by telegraph took place at the instance of Professor Wheatstone in London in 1845, by Mr. H. Staunton and Captain Kennedy against Messrs. Buckle, Perigal, Walker, and Tuckett. It was drawn after eight hours' play.

A CHESS-PLAYING automaton has been on exhibition at the New York Aquarium for the past year, but as it seems to be conducted by what is termed a "rook player," it has been badly beaten and has attracted but little notice.

When the original Automaton Chess Player visited Boston in 1826, a certain "H. B." addressed a poem, through the newspapers, to the mysterious Turk. It concludes thus:

Now just confide in me and show,
Or tell how things witbin thee go!
Speak in my ear so quick and low,
None else shall know it.
But, mark me! if I should discover,
Without thine aid thy secret mover,
With thee forever all is over—
I'll quickly blow it!

A NEW chess circle has been formed in Brooklyn, entitled the "Paul Morphy Chess Association." Meetings are held every Thursday at the residences of the members, business meeting once a month.

The officers are: President, E. Lapidge (Bedford avenue corner Gates); Vice-President, J. A. Wood; Secretary and Treasurer, A. Buck; Librarian, A. Edmonstone.